LISBOA SCHOOL OF ECONOMICS & MANAGEMENT

MASTER OF SCIENCE IN MONETARY AND FINANCIAL ECONOMICS

MASTER FINAL WORK

DISSERTATION

What Is the Size and Cyclicality of Mark-ups in Portuguese Industries?

ANDRÉ FILIPE FIGUEIREDO SILVA

APRIL - 2015

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Abstract

This dissertation provides new insights on the estimation of mark-up ratios in Portugal, using annual panel data for Portuguese manufacturing industries over the period 2004-2010. I used a production-function approach for single-product firms and made weak assumptions on the productivity stochastic process. The main difference from this empirical setting is that I used product-level quantity and price information, rather than firm-level revenues. The conclusion rests on the finding that mark-up ratios or price-marginal cost ratios, are significantly larger than one in general, i.e. prices tend to be larger than marginal costs. This study also contributes for the discussion on the cyclicality of mark-ups and provides evidence that they tend to be countercyclical with GDP.

KEYWORDS: Mark-ups, Productivity, Production Function.

JEL CODES: C23, C36, D24, D43, E32, L22

CONTENTS

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1 INTRODUCTION

The main purpose of a mark-up indicator is to measure the market power of a firm, an industry, a sector. It postulates the firm's capacity to set the price above its marginal cost; a mark-up ratio bigger than 1 implies that prices are higher than the marginal cost, which is an evidence of market power. Therefore, estimating the monopoly degree in a specific sector is important not only for academics or scholars, but also for competition regulators or policymakers. Likewise, competition regulators or authorities would like to know if the current regulation is conducive to competition or not. Also, as mark-up estimations vary across countries, industries and even firms it will help to better understand what kind of political or economic policy decisions can be implemented that affect competition, and to note the importance of doing a comparison between sectors or even countries, which should be helpful in order to identify which sectors would benefit from changes in legislation or regulation that affect competition. Also, an environment with a high degree of competition may lead to a more efficient reallocation of resources and foster innovation.

This dissertation contributes to the existing literature by providing new insights on the importance of the size of mark-ups as a market power indicator and on its respective cyclicality when related to GDP. It does so by expanding, notably, Santos' *et al.* (2014) core specification, in order to obtain the measurement of market power. I conduct an assessment of mark-ups using the same criteria. However, in addition to this, I also identify other single-product industries and study their relation or correlation with prices, quantities, revenues and added value. Also, in this dissertation I use firm-level data with information to estimate mark-up based on prices and quantities. The firm-level data give me crucial information to understand the components of competitiveness, as industry performance depends solely on the firm's decisions. Furthermore, most authors estimate mark-ups with revenues instead of quantities and using a single firm as a representation of an entire industry[1] or country[2], which may lead to implausible measurement of mark-ups and which could hide the degree of dispersion across sectors. The same could be pointed out about the use of the aggregation level to identify the single-product industries, since it can include quite different products in the same industry, i.e. huge product heterogeneity inside the same industry or sector.

The results presented may not be of high importance since this aggregation occurs at product level, hence, the possibility of not being able to identify the key industries, which is the reason behind the difference when compared to the market investigations made by competition authorities. Nevertheless, the results are a good first approach to identify industries that may have conditions to create or extend their market power and, therefore, to exclude the entry of new firms into the sector or industry.

The dissertation is organised as follows: section two presents a brief review of the main related literature; section three presents the methodology for the production-function estimation; in section four, I present a brief summary of the data used; in section five, I conduct the empirical analysis of the mark-up and productivity distributions in a sample of industries; section six presents the analysis of mark-up cyclicality; finally, section seven concludes and points out some possible topics for future research on this subject.

[1] See, for example, Martins *et al.* (1996), amongst others.
[2] See, for example, Afonso & Costa (2013)

2 LITERATURE

2.1 Measuring Market Power

Estimating mark-ups has a long tradition in Industrial Organization[3] (IO). The mark-up expresses the power firms have to set a price above the cost of producing an additional unit of output, i.e. the market power. The identification and the estimation of production functions using data on inputs and outputs is an old empirical problem in economics[4]. Most of the literature proposes two ways of measuring mark-ups: the first one is using cost functions and the second one is using production functions[5]. The latter is more common, although it requires more assumptions about optimization. The main issue in constructing measurements of mark-up, lies in the fact that marginal cost cannot be measured directly. Most common measurements of marginal costs consider an increase in the cost of an input as a consequence of increasing output. Therefore, it is not easy to obtain suitable measures of marginal cost, since all of the measures are obtained indirectly and rely on the production or cost function of each firm. Another important issue are the theoretical problems posed by production functions. Rotemberg & Woodford (1999) point out several reasons why standard assumptions on production functions may lead to biased or spurious estimates of the mark-up via its influence on the marginal cost. Some of these reasons are: i) the functional form of production function; ii) the inputs considered; iii) returns to scale. Furthermore, concerning the inputs, the issue is if they are pre-determined or not, and if they are substitutable or not.

Concerning the reasons above, some examples are presented: i) the functional form

[3] See, for instance, Hall (1988), Roeger (1995) and Martins *et al.* (1996).
[4] As seen in Gandhi *et al.* (2013).
[5] For the production-function approach see Christopoulou & Vermeulen (2012); for the cost-function approach see Santos *et al.* (2014)

of the function may have an influence, as in the special case of a Cobb-Douglas production function, for which marginal cost is proportional to average input cost; ii) it is plausible to reduce marginal cost if the firm finds a less costly input in substitution of another; concerning iii), if a firm exhibits constant returns to scale, the marginal cost will be constant. As pointed before, Rotemberg & Woodford (1999) and Nekarda & Ramey (2013), amongst others, point out some of these theoretical problems that affect the marginal cost and lead to a biased estimation of mark-ups.

Apart from the above-mentioned reasons, the empirical research in this topic is not abundant. However, there are several papers that try to measure mark-ups levels following Hall (1988) that suggests a simple way to estimate mark-ups. Hall's article relies on the cost share of inputs in total cost to identify the mark-up. He applied his method to 26 industries from 1953 to 1984 and noticed that prices exceeded marginal costs. The size of the mark-up ratio estimated by Hall, in many cases, is clearly above 100 per cent.

Roeger (1995) is another example of the literature on measuring mark-up levels in different industries. This methodology uses the difference between the Solow Residual obtained from profit maximization and cost minimization of the firm. He uses a panel of 24 U.S. manufacturing industries for the same period, as in Hall (1988). The mark-up obtained is substantially lower when compared to Hall. Also, Roeger presents two topics for the value of mark-up – excess of capacity and labour hoarding. Comparing both Hall's and Roeger's results to mine, they present a much higher mark-up, considering that they assume that a firm is representing the entire sector or industry.

Martins *et al.* (1996) also measure mark-up levels in several industries, for a panel of 36 industries from 14 OECD countries, by using an extend version of Roeger's method. In comparison with the authors cited above, they compute substantially lower mark-ups. The estimated mark-ups are low, or close to one, in all countries data concerning industries such as textiles, clothing, footwear and machinery. The authors argue that the size of the mark-up obtained is related with the market structure (establishment size, degree of vertical integration, amongst others).

Christopoulou & Vermeulen (2012) also use a version of Roeger's method to measure the mark-up levels for several countries and industries. These authors use a panel of 50 sectors of 8 euro-area countries and the US, between 1981 and 2004. They conclude that mark-ups are generally higher in services sectors than in manufacturing industries. Also, that mark-up ratios differ widely across sectors, with some sectors having systematically higher mark-up ratios than other sectors, e.g. a) tobacco, when we consider the manufacturing industries, b) Real Estate Activities, when we consider the services sector. As pointed out by Martins *et al.* (1996), there are some stylized factors that influence the market power, such as barriers to entry, product differentiation and exposure to international competition.

More recently, Amador & Soares (2012) provides an overview of competition indicators for Portuguese economy in the period of 2000-2009. The first one is obtained through the Herfindahl–Hirschman index (HHI) and the second one through the Price-cost margin (PCM). They classify markets as: a) tradable sectors, if they are part of the manufacturing markets, and b) non-tradable sectors, when dealing with the non-manufacturing markets, given the firm's market power is exposure to international competition. The article covers concentration and profitability measurements and concludes that markets where concentration increased are in general the ones that present low values of HHI, especially in the non-tradable sector. Regarding profitability, positive trends are more widespread in the tradable sector, compared to non-tradable sector.

To sum up, most of the literature supports the view that, in general, prices in most sectors tend to exceed marginal costs by a statistically significant amount. Furthermore, mark-up levels tend to differ across sectors or industries, and across countries. The authors present some stylised factors as the main influence in the mark-up level, such as barriers to entry, exposure to the international competition and product differentiation, amongst others.

The cyclicality of mark-ups is one of the most challenging measurement problems in macroeconomics. Rotemberg & Woodford (1991, 1999), Martins & Scarpetta (2003) and, more recently, Nekarda & Ramey (2013), Afonso & Costa (2013), Juessen & Linnemann (2012) and Hall (2009) have produced some research on the cyclicality of mark-ups.

Most authors agree that mark-ups tend to behave in a countercyclical manner, as they vary in the inverse way of real marginal costs. Rotemberg & Woodford (1999) use the cyclical behaviour of labour share to conclude that mark-ups are unconditional. Afonso & Costa (2013) find that mark-ups are countercyclical to fiscal shocks for 6 of 14 OECD countries. However, Nekarda and Ramey (2013) present evidence suggesting that mark-ups are largely procyclical or acyclical to demand shocks for US industries. These authors also investigate the role of mark-up cyclicality in the transmission mechanism of macroeconomic shocks. Nekarda and Ramey (2013) present two measurements of cyclicality: the first one is a conditional cyclicality, which analyses the behaviour of mark-ups in response to identified shocks (also, they mention that mark-ups tend to behave pro-cyclically with supply shocks – according to them, mark-ups are not countercyclical to fiscal shocks, i.e. demand shocks); the second one is a non-conditional cyclicality, i.e. analysing just the correlation of Gross Domestic Product (GDP) with the mark-up or the its correlation with prices or quantities.

2.2 Estimating Production Functions

The estimation of production functions is a main fundament of economics. As first pointed out by Marschak & Andrews (1944), a solid and correct identification of the production function is related to the firm's optimal choice of inputs, in order to maximize the profits or minimize costs. This gives rise to the input-endogeneity problem and, therefore, it can bias the econometric results.

However, there are some attempts to solve the input-endogeneity problem that are common to the majority of the studies. One set of techniques relies on using observed input decisions to proxy unobserved productivity shocks, e.g. Olley & Pakes (1996) (henceforth OP), Levinsohn & Petrin (2003) (henceforth LP), and Ackerberg *et al.* (2006) (henceforth ACF). Alternatively, we can use dynamic panel-data techniques, e.g. Arellano & Bond (1991), Blundell & Bond (2000) and Bond & Soderbom (2005). I will focus on the first set of techniques.

Note that both the OP and LP methods rely on some assumptions besides the first-order Markov process and the fact that productivity evolves exogenously. ACF points out that, besides being an important econometric assumption, it is also an economic assumption, as productivity expectations will depend solely on time *t*.

The chosen technique implies some assumptions: the first is the strict monotonicity in productivity; the second is that productivity is the only unobservable variable; the final assumption relates the timing and dynamic implications of input choices. The timing, here, refers to the point in the productivity process at which inputs are chosen, creating a moment condition. The use of lagged decisions to adress the current value as assumed by OP, LP and ACF raises the problem of multicollinearity and, once again, leads to a bias in the econometric results.

More recently, many authors, such as Bond & Soberdom (2005), Ackerberg *et al.* (2006), Wooldridge (2009) or Ghandi *et al.* (2013) have raised a concern with the multicollinearity-problem. In order to avoid the multicollinearity problem, all inputs should be costly to adjust. Bond & Soberdom (2005) point out that the existence of adjustment costs and productivity shocks that vary across firms implies that input prices also vary across them and break the collinearity between the levels of different inputs, i.e. that this is only a concern if there is no other source of variation to the input demand besides the state variables.

Klette & Griliches (1996) and, more recently, De Loecker (2007) referred the problem of using revenues instead of quantities as the dependent variable. Since price is determined in function of quantities, when we use revenues as a proxy for output (quantities), both the production function and the real productivity are not identified, and the residual usually contains both supply and demand shocks, i.e. since firms do not necessarily post the same price, when output prices are not observed, deflated revenues do not measure properly the quantity that the firm produces. I do not have this measurement problem, since I make use of rich firm-level price data that allow me to estimate production functions in quantities instead of revenues.

3 METHODOLOGY

The strategy for measuring the market power or mark-up is based upon Santos *et. al.* (2014). It consists in estimating the production function for single-product firms, using common input factors such as labour, physical capital stock and intermediate inputs. Also, firms are assumed to work in imperfectly competitive markets, characterized by few sellers, with the power to set prices above marginal costs and many price-taking buyers. If the firm was inserted in a perfectly competitive market, the mark-up would be equal to one, since the price would be equal to the marginal cost. The standard approach in the literature is to use a sectorial classification as a market segmentation. The assumption is that firms sell one good and compete in only one market. Therefore, multi-product firms are a source of bias, especially if products are not close substitutes. Apart from that, my option for single-product firms concerns the difficulty of identifying concretely and specifically the inputs allocation, i.e. the portion applied of each input used in different production processes. Besides this assumption, there is a difficulty in specifying multi-product production functions, since there is huge diversity in the nature of outputs estimated and since there are multiple equations that are needed and a large number of restrictions for each one. As we can see in table IX in appendix A.1, around 26 per cent of the sample are single-product firms and, from these, I selected industries that had a sufficient number of firms each year to allow for estimation, i.e. more or less 20 per year on average. This option may raise some criticism since the inclusion of multi-product firms would guarantee a higher representativeness, because most firms produce more than one product.

Finally, the option for the median mark-up, instead of the average mark-up, which is more common in the literature, addresses the fact that the average may not be a robust tool, since it is largely influenced by outliers. Apart from that, the median is better suited for skewed distributions to derive to a central tendency.

The mark-up level, that here is the price-marginal cost ratio, is defined as

$$\mu_{ijt} = \frac{p_{ijt}}{MC_{ijt}}, \tag{1}$$

where p_{ijt} represents the price of good j for firm i at time t. I assume that firm i produces good j using a general production function with substitutable inputs:

(2) $$q_{ijt} = F_j\left(K_{ijt}, L_{ijt}, M_{ijt}, A_{ijt}\right),$$

where q_{ijt} represents the quantity of good j produced by firm i at time t, K_{ijt} stands for the physical capital stock held by the firm, L_{ijt} is labour, M_{ijt} stands for materials (intermediate inputs), and A_{ijt} stands for unobservable total factor productivity (TFP).

If the firm maximizes its profits, its marginal cost is given by

(3) $$MC_{ijt} = \frac{p_{ijt}^{x}}{MPx_{ijt}},$$

where x = K, L, M and MPx_{ijt}, is the marginal product of input x, and p_{ijt}^{x} represents its price, with $p_{ijt}^{L} = w_{it}$ being the nominal wage rate, $p_{ijt}^{K} = r_{it},$ is the rental price of capital and p_{ijt}^{M} is the price of the materials.

Considering the marginal product of x is given by

(4) $$MPX_{ijt} = \frac{\partial F_j}{\partial x_{ijt}}\left(K_{ijt}, L_{ijt}, M_{ijt}, A_{ijt}\right),$$

Thus, if we substitute eq. (3) and (4) in (1), we obtain

$$\mu_{ijt} = \frac{p_{ijt}}{p_{it}^{x}} MPx_{ijt} = s_{ijt}^{x} \frac{MPx_{ijt}}{APx_{ijt}},$$

where $s_{ijt}^{x} = \frac{p_{it}^{x} x_{ijt}}{Y_{ijt}}$ is cost share of input x as a proportion of total revenue $\left(Y_{ijt} = p_{ijt} q_{ijt}\right)$ and $APx_{ijt} = \frac{q_{ijt}}{x_{ijt}}$ is the average product of input x. In my model I will focus on intermediate inputs (materials). This option addresses the fact that it is less costly to adjust the usage of materials than that of labour. In the literature presented in section 2, labour is the most common input factor used.

Let $\eta_{ijt}^{x} = \frac{MPx_{ijt}}{APx_{ijt}}$ denote the input elasticity and so that eq. (1) can be written as

(5) $$s_{ijt}^{x} = \frac{\eta_{ijt}^{x}}{\mu_{ijt}}$$

Thus, we obtain a system with two equations:

(6) $$\begin{cases} ln\, q_{ijt} = ln\, F_j\left(K_{ijt}, L_{ijt}, M_{ijt}, A_{ijt}\right) \\ ln\, \mu_{ijt} = ln\, \eta_j^x\left(K_{ijt}, L_{ijt}, M_{ijt}, A_{ijt}\right) - ln\, s_{ijt}^x \end{cases}$$

In this system, we need only to estimate the first equation. From the estimation procedure we identify η_j^x , the input's elasticity, and s_{ijt}^x , the cost share of the input, is obtained from the data. In the system above, we have only two unobservable variables: A_{ijt} and μ_{ijt}.

Let us assume a Cobb-Douglas production specification for eq. (2):

$$q_{ijt} = A_{ijt} K_{ijt}^{\alpha_j} L_{ijt}^{\beta_j} M_{ijt}^{\delta_j}$$

where $\alpha_j, \beta_j, \delta_j \epsilon\ (0,1)$. In this case, we obtain $\eta_{ijt}^x = \alpha_j,\ \beta_j$ or δ_j, i.e. the output elasticity of the inputs is constant. Since I assumed a Cobb-Douglas[6] production function, the technology is Hicks-neutral. Therefore eq. (6) becomes:

$$\begin{cases} \ln q_{ijt} = \alpha_j \ln K_{ijt} + \beta_j \ln L_{ijt} + \delta_j \ln M_{ijt} + \ln A_{ijt} \\ \ln \mu_{ijt} = \ln \delta_j - \ln s_{ijt}^M \end{cases}$$

As Olley & Pakes (1996), Levinshon & Petrin (2003) and Ackerberg *et al.* (2006) pointed out, the input-endogeneity problem arises once TFP and mark-ups are unobserved and correlated with inputs. Following Olley & Pakes (1996), I introduce a standard Markovian assumption about the TFP stochastic process.

Assumption 1: Productivity evolves according to a first-order Markov process given by

(7) $$\ln A_{ijt} = g\left(\ln A_{i,t-1}\right) + \gamma_{it}\ ,$$

where *g(.)* is a general function and γ_{it} is *i.i.d.* over *i* and over *t* .

Since I assume that TFP follows a first-order Markov process in a model that has a dynamic common factor representation, there is no need to specify input demand

[6] The option for a Cobb-Douglas production function concerns the fact that it is easier and simpler to estimate and to interpret and requires estimation of a small number of parameters when compared to a Translog. Besides this fact, it has one main advantage, which is that all firms have the same production elasticities and that substitution elasticities equal one. For other examples of production functions, like Translog, see, for example, Santos *et al.* (2014) or Gandhi *et al.* (2013).

functions – see further information in Blundell and Bond (2000)[7]. Under this assumption, state variables are uncorrelated. Violations of the Markov assumption will generate serial correlation and γ_{it} would be correlated with the state variables, and this instrument would not be valid[8]. Furthermore, predetermined variables are also valid instruments, e.g. the capital stock or labour (especially skilled labour) when it is chosen at the end of period *t-1*.

Therefore, if we substitute eq. (7) in the Cobb-Douglas case, our estimating equation becomes:

$$\ln q_{ijt} = \alpha_j \ln K_{ijt} + \beta_j \ln L_{ijt} + \delta_j \ln M_{ijt} + \ln A_{ijt} = \alpha_j \ln K_{ijt} + \beta_j \ln L_{ijt} + \delta_j \ln M_{ijt} + g\left[\ln q_{ij,t-1} - \alpha_j \ln K_{ij,t-1} - \beta_j \ln L_{ij,t-1} - \delta_j \ln M_{ij,t-1}\right] + \gamma_{it} \tag{8}$$

Following Hu & Shum (2012) once more, the generalized method of moments (GMM) estimator uses the following orthogonality conditions:

$$E\left(\gamma_{it}\begin{bmatrix} h^1\left(q_{ij,t-1}, K_{ij,t-1}, L_{ij,t-1}, M_{ij,t-1}\right) \\ \cdots \\ h^P\left(q_{ij,t-1}, K_{ij,t-1}, L_{ij,t-1}, M_{ij,t-1}\right) \\ K_{it} \\ L_{it} \end{bmatrix}\right) = 0 \tag{9}$$

where $h^P(.)$ for p = 1,…, P are polynomials of order p. The GMM estimator is used eliminate unobserved firm-specific effects.

[7] The common factor is γ_{it}, since it connects different coefficients on the same variable with a first or higer-order difference lag.
[8] See further information in Hu and Shum (2012)

4 DATA DESCRIPTION

The dataset consists of an annual frequency panel ranging from 2004 to 2010, including price data. This allows me to avoid the problem identified by Klette & Griliches (1996) when using revenues instead of quantities.

The dataset was constructed from two sources. The first data source is a sample of firms surveyed: IAPI (*Inquérito Anual à Produção Industrial*), available for the period of 1992-2011 and containing very detailed 12-digit product information, including total revenues and quantities, both produced and sold. Prices are collected for each firm and each product. This survey covers roughly 8,000 firms per year and an average of nearly 42,000 products per year. The second source is a census of firm-level financial data: IES (*Informação Empresarial Simplificada*), available for the period of 2004-2010 and covering all domestic firms. For my analysis, I considerer manufacturing industries that do not belong to sole proprietors. This source covers around 1 million firms per year, but after these exclusions, the universe of registered firms is around 300,000 per year. This census has financial information, usually presented in balance sheets and some employment and investment statistics.

IES had a previous version, though it was a survey instead of a census, named IEH (*Inquérito às Empresas Harmonizado*), available for the period of 1996-2004. However, since it covered a sample of the firm population, it did not contain full information and it was difficult to cross it with IAPI, because the samples were independently drawn. Besides this, I also restrict myself to industries with, at least, 20 observations per year, on average, in order not to obtain biased estimations due to small sample sizes.

Another important issue is the selection criteria of single-product firms and the level of aggregation. As the information on products is very detailed, I aggregate it at 5 and 7 digits, instead of at a 12-digit product level, taking into account the measurement units. The measurement units criterion also excludes some industries, since it is not plausible to match different measurement units (e.g. litres with pounds), and, therefore, this would lead to biased estimations.

The selection criterion of single-product firms also consists in setting a minimum proportion of revenues originated by the firm's most important product.

Another important issue is the definition of variables. The set of variables required to estimate eq. (7) is relatively wide. Firstly, I exclude all firms that have less than 3 employees. This option adresses the low variability of employment in this kind of firms.

The physical capital stock is always quite difficult to measure. The measurement of physical capital stock presented here follows the perpetual-inventory method (PIM)[9]. Applying the measures of assets and investment presented in the data I use the following equation:

(10) $$K_{t-1} = K_{\mathrm{t}}(1-\delta) + (\,Inv_{\mathrm{t}} - Desinv_{\mathrm{t}})\ ,$$

where Inv is the investment and $Desinv$ is the desinvestment. The depreciation rate of manufacturing industries[10] (δ), was constructed using the variables taken from the European Commission AMECO database.

Finally, the intermediate inputs were measured by adding the series of cost of goods sold and consumed and supplies and services. In eq. (11), I present a price deflator for intermediate inputs that is common to all the firms:

(11) $$\begin{cases} P_m = \dfrac{M_n}{\dfrac{Y_n}{P_y} - \dfrac{VA_n}{P_v}} \\ P_y = 1\ for\ t = 2004 \\ P_v = 1\ for\ t = 2004 \end{cases}$$

[9] PIM is a method of constructing estimates for the physical capital stock and consumption of fixed capital from time series of gross fixed capital formation.
[10] Further details on the construction of physical capital stock are presented in Appendix A.2.

where P_m is the price deflator of intermediate inputs; M_n stands for the intermediate inputs, constructed through IES; Yn represents revenues; P_y represents the price index for output; VA_n stands for nominal value added and P_v is the price index for value added.[11] The following equations represent the price index of output and value added, respectively:

$$P_{y,t} = \frac{P_{y,t+1}}{\frac{Y_{n,t}}{Y_{n,t-1}}} \text{ and } P_{v,t} = \frac{P_{v,t+1}}{\frac{VA_{n,t}}{VA_{n,t-1}}} .$$

Concerning all these assumptions, I adduce table I, which presents the sample size of firms per industry and year of single-product firms with 100 per cent of total revenues as the selection criterion. This selection criterion leads me to a sample that represents just 5 per cent of usable sample firms, i.e more or less 350.00, as we can see in table XI appendix A.1, and that fact, may not guarantee the representativeness required.[12] This classification and choice of single-product firms can be criticised as being too simplistic, although it is a good starting point for analysing the levels of mark-ups.

[11] The variables were taken from *Instituto Nacional de Estatística* (INE): Yn_t – C.1.2.1 ; VAn_t – A.1.4.4.1

[12] See for instance, in appendix A.1 a set of tables with the information of the dataset selection and a comparison of summary statistics for some variables between single and multi-product firms.

TABLE I Sample Size of Firms per Industry and Year

CAE 2.1	Digit Level	Industry	Total	2004	2005	2006	2007	2008	2009	2010
15811	7	Bakery	924	176	180	145	124	102	97	100
10830	5	Coffee	163	25	25	25	23	20	23	22
15860	5	Cork	1443	230	265	242	211	171	164	160
26120	7	Glass	156	22	28	23	23	19	20	21
36130	5	Kitchen Furniture	649	93	111	114	102	79	73	77
17720	5	Manufacture of clothes of knitwear	516	84	87	82	83	61	62	57
26610	5	Manufacture of concrete for building	631	110	111	110	104	64	66	66
15710	5	Manufacture of Food for livestock	399	60	64	56	61	55	46	57
17600	5	Manufacture of knitwear	413	64	69	65	59	49	54	53
18221	5	Manufacture of other Outwear	932	144	167	157	145	120	102	97
21211	5	Manufacture of paper	181	31	29	27	25	23	25	21
25210	5	Manufacture of Plastics	272	43	40	41	41	37	35	35
28120	5	Metal Doors, Windows	1930	231	265	287	295	246	303	303
15510	7	Milk and dairy Products	283	51	49	41	35	32	34	41
29563	5	Moulds	888	138	136	135	132	112	117	118
15412	5	Olive Oil	287	34	37	33	34	35	38	76
15812	7	Pastries	801	143	143	128	119	89	90	89
19301	7	Shoes	1554	242	256	233	202	199	210	212
26701	5	Stone Cutting	2032	237	282	273	277	292	353	318
15931	7	Wine	224	33	29	36	25	32	31	38
36141	5	Wood Furniture	2078	295	344	326	284	250	300	279

Source: Author's Computation

Note: Number of firms per year at 100% criteria at 5 and 7 digits level aggregation of product code between 2004-2010

5 EMPIRICAL ANALYSIS

5.1 Interpretation and Possible Estimation Biases

The results of the estimation of the production function in eq. (8), using both linear and cubic polynomials to approach the stochastic process for productivity, and using the share of intermediate inputs to measure mark-ups, are presented in Table II[13]. Besides the estimation of the production function with GMM, I also tried using Ordinary Least Squares (OLS). The results are presented in Appendix B.1 and, as expected and pointed out in the literature, OLS estimations of the coefficients are biased and inconsistent[14].

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[13] Estimates for the coefficients and standard errors and values of the *g*(.) function in eq. (8) are presented in Table XVIII as are estimations for the same equation but with just capital stock as an instrument, i.e. when labour and intermediate inputs are not predetermined.

[14] What is shown in Appendix B.1 are the results of the OLS estimation of a Cobb-Douglas production function for quantities, revenues, and value added. Two cases are presented. The first one does not consider intermediate inputs and the mark-up is measured by labour share. The second one may include intermediate inputs and the mark-up is obtained from the materials share. In Appendix B.3, we can find estimations for the following topics: i) GMM estimations using labour share to measure mark-up in Table XX, ii) GMM estimations using both labour and intermediate inputs share to measure mark-up in Table XXII, iii) GMM estimations using labour share to measure mark-up, without intermediate inputs in Table XXI.

Figures 6 to 11, shown in Appendix B.1, exhibit a comparison of mark-ups estimated with quantities, revenues and value added as dependent variables using OLS[15].

TABLE II GMM Estimates for the Coefficients of the Production Function

TFP transition	Linear Aproximation					Cubic Aproximation				
Industry	RtS	δ	β	α	Median Markup	RtS	δ	β	α	Median Markup
Bakery	0.909	0.801***	0.108	0.000	1.443	0.971	0.659***	0.312	0.000	1.187
Coffee	0.912	1.077***	-0.166	0.001	1.703	1.373	0.642***	0.737***	-0.006***	1.014
Cork	1.041	0.785***	0.256	-0.001	0.967	1.109	0.890***	0.222	-0.003	1.096
Glass	1.123	0.949***	0.172	0.002	1.566	1.624	0.622**	0.994***	0.008***	1.026
Kitchen Furniture	1.325	0.915	0.405	0.005	1.306	1.288	1.042	0.241	0.004	1.487
Manufacture of clothes of knitwear	0.795	0.223	0.570***	0.002	0.459	1.183	0.622**	0.690***	0.003**	1.010
Manufacture of concrete for building	0.919	0.786***	0.137	-0.004***	1.115	0.852	0.846***	0.009	-0.004*	1.201
Manufacture of Food for livestock	1.052	1.006***	0.046	-0.001	1.093	0.958	0.942***	0.015	0.002**	1.023
Manufacture of knitwear	0.902	0.907***	-0.008	0.003*	1.194	0.894	0.881***	0.009	0.003*	1.161
Manufacture of other Outwear	0.628	0.544***	0.082	0.002	1.185	0.691	0.531***	0.159*	0.001	1.155
Manufacture of paper	1.325	0.984***	0.343**	-0.002	1.322	1.314	1.062***	0.253	-0.002	1.426
Manufacture of Plastics	0.766	0.823***	-.060	0.002	1.029	0.912	1.134***	-0.230	0.008**	1.417
Metal Doors and Windows	0.914	0.889***	0.023	0.002	1.359	1.004	0.689***	0.317	-0.002	1.053
Milk and dairy Prodcuts	0.917	0.918***	-0.006	0.005**	1.182	0.922	0.936***	-0.019	0.004**	1.206
Moulds	0.607	0.409***	0.204	-0.006***	1.118	0.748	0.588***	0.166	-0.006***	1.608
Olive Oil	1.250	0.921***	0.293***	0.035***	0.999	0.815	0.729***	0.073***	0.013***	0.790
Pastries	1.008	0.965***	0.039	0.004**	1.495	0.998	0.984***	0.010	0,003	1.526
Shoes	1.034	1.008***	0.027	-0.002	1.610	1.057	0.857***	0.201	-0.001	1.368
Stone Cutting	0.889	0.728***	0.159	0.002	1.170	0.988	0.767***	0.220	0.001	1.233
Wine	0.645	0.821**	-0.167	-0.009	1.115	0.789	0.744*	0.055	-0.011	1.011
Wood Furniture	0.982	0.882***	0.098	0.002	1.510	1.193	0.623***	0.568*	0.002	1.066

Source: Author's Computation
Nothes: The set of instruments is the level of capital stock and employment together with linear terms (for linear approximation), quadratic and cubic terms (for cubic approximation) of all variables lagged one period.
*,**,*** denotes statistacally significant at 10, 5 and 1 per cent level, respectively.

First, the column presenting the levels of returns to scale (RtS), in Table II, shows us that most industries exhibit constant returns to scale, i.e. the values for $\alpha_j + \beta_j + \delta_j$ that are close to one. However, Moulds and Wine may show decreasing RtS. On the other hand, Manufacture of paper, and Metal doors and Windows may exhibit increasing RtS.

Table III presents the results of the formal t-test described above. The following statistical test has a greater importance because some industries exhibit a small sample size and this may lead to spurious coefficients. We can observe, in Table III, that, at 1 per cent significance, only Olive oil and Manufacture of outwear reject the hypothesis

[15] From these results, we can conclude that quantities produce higher mark-ups when compared to revenues, but lower when compared to value added, using the labour share to measure mark-ups. If we introduce intermediate inputs, the mark-ups are higher when quantities are used as a dependent variable, instead of revenues or value added.

of constant returns to scale for both approximations. These results are similar to the ones presented in the previous paragraph.

TABLE III Returns to Scale Test at 1 per cent significance

	Linear	Cubic
Industry	*p-stat*	*p-stat*
Bakery	0.258	0.791
Coffee	0.395	0.000
Cork	0.760	0.529
Glass	0.571	0.000
Kitchen Furniture	0.137	0.421
Manufacture of Clothes of Knitwear	0.128	0.298
Manufacture of Concrete for Building	0.545	0.366
Manufacture of Food for Livestock	0.506	0.155
Manufacture of Knitwear	0.282	0.065
Manufacture of other Outwear	0.000	0.000
Manufacture of Paper	0.038	0.007
Manufacture of Plastics	0.000	0.527
Metal Doors and Windows	0.203	0.957
Milk and Dairy Products	0.162	0.238
Moulds	0.026	0.157
Olive Oil	0.002	0.000
Pastries	0.898	0.976
Shoes	0.625	0.477
Stone Cutting	0.271	0.957
Wine	0.171	0.802
Wood Furniture	0.784	0.210

Source: Author's computation
P-Stat represents the probability of RtS being different from one

Another important issue are the values estimated for the coefficients. The low values obtained for α, in some cases even negative, e.g. Coffee or Moulds, are odd from an economic point of view. The low or non-significant estimates may be due to the fact that the time dimension of the panel is short and the physical capital stock does not have enough time variability at the firm level.

On the other hand, we can observe high values for the estimates of δ, the elasticity of materials, as I assume that the input factors are substitutes and that intermediate inputs are easily adjusted by the firm, allowing for higher variability.

The estimated values for β are usually positive, with some exceptions, e.g. Manufacture of knitwear, Manufacture of plastics, Milk and dairy products and Wine. As we can see in Table II, none of them is statistically significant. It is important to point out that most of the literature, e.g. Rotemberg & Woodford (1999), amongst others, do not use intermediate inputs or materials, but labour to estimate the mark-up.

Also, it is important to explore the validity of the instruments used. The analysis of the validity is presented in Table IV, which contains the results for the Sargan-Hansen statistical test. The joint null hypothesis is that the instruments used are valid, i.e. that they are uncorrelated with residuals. We can observe that, at 5 per cent significance, only in Manufacture of outwear and in Manufacture of concrete for building is the null hypothesis rejected, i.e. the instruments may not be valid for this equation or they may be incorrectly used. Considering the cubic approximation instead of the linear one, results may differ, but not significantly. For the industries identified above, along with Olive oil and Wine, we reject the null hypothesis at 5 per cent significance.

TABLE IV Validity of the Instruments

	Linear Approximation			Cubic Approximation		
Industry	J Stat	Degrees of Freedom	P-Value	J Stat	Degrees of Freedom	P-Value
Bakery	10.002	12	0.616	9.817	7	0.196
Coffee	7.011	12	0.857	3.289	7	0.856
Cork	5.415	12	0.943	3.312	7	0.855
Glass	8.704	12	0.728	5.798	7	0.564
Kitchen Furniture	4.177	12	0.980	4.114	7	0.766
Manufacture of clothes of knitwear	17.146	12	0.144	9.009	7	0.252
Manufacture of concrete for building	22.836	12	0.029	20.992	7	0.04
Manufacture of Food for livestock	15.638	12	0.208	8.148	7	0.319
Manufacture of knitwear	6.064	12	0.913	2.895	7	0.895
Manufacture of other outwear	25.314	12	0.013	26.985	7	0.03
Manufacture of paper	12.984	12	0.370	7.361	7	0.392
Manufacture of Plastics	15.416	12	0.219	8.026	7	0.330
Metal Doors and Windows	19.136	12	0.085	17.129	7	0.017
Milk and dairy Products	7.516	12	0.822	3.557	7	0.829
Moulds	12.370	12	0.416	9.978	7	0.254
Olive Oil	12.606	12	0.398	12.863	7	0.095
Pastries	12.865	12	0.379	4.955	7	0.665
Shoes	7.027	12	0.856	4.123	7	0.766
Stone Cutting	20.871	12	0.052	17.445	7	0.126
Wine	5.854	12	0.923	5.078	7	0.065
Wood Furniture	18.101	12	0.113	2.111	7	0.953

Source: Author's computation

Notes: the J-Stat presented is The Sargan-Hansen test

Another issue that is important to analyse are the values of the *g*(.) function presented in eq. (8). In Table II, we can observe a difference between the results of median mark-up for Coffee and Glass with linear and cubic approximations. Besides the reasons previously mentioned, the values of the coefficients in the $g(.)$ function also influence the results, as we can see in Table XIX, presented in appendix B.2. For the industries mentioned, it is possible to see the difference between the values of the $g(.)$ function for the linear and cubic approaches, which consequently leads to a difference in estimated mark-ups. Also, and according to Klette & Griliches (1996), using quantities instead of revenues to estimate the production function results in higher mark-ups. The reason for this difference is related to the use of deflated sales as the dependent variable. The main idea is related to a cost improvement, when compared to the other firms of the industry, which allows for a reduction in the price and, therefore, expands the market share of the firm. It follows, due to the correction of relative prices, that replacing changes in real output by growth in deflated sales will introduce a bias in parameters. I did not address these kinds of problems, since my method uses the prices obtained by dividing revenues by quantities. This method provides more accurate estimates of the median mark-up level and allows us to understand its true value, i.e. the monopoly degree.

5.2 Interpreting Mark-ups

The industrial organization literature[16] typically associates the mark-up level to a range of structural variables such as establishment size, capital intensity, vertical integration, economies of scale or scope, product differentiation, capital intensity, exposure to international competition, R&D, amongst others, although the rationale for mark-up levels differs depending on the type of industry. To identify the type of competition and relate it to the mark-up estimates, I will focus on a few indicators.

[16] See, for example, Martins *et. al.* (1996).

The first indicator that I will analyse is the average firm size. The firm size is a proxy for the existence of size advantage, like scale economies at the firm level as pointed by Martins *et al* (1996). It is expected, in this kind of industries, that a large average firm size may exhibit large firms that cover a large percentage of the employment and of the output of the industry. For this reason, I analyse the relation between the median mark-up and the median size of each industry, taking into account the output, i.e. the volume of sales. As far as we can see in figure 1, in general, firms that exhibit a larger median output may tend to display smaller median mark-ups. This might be odd from an economic point of view, that firms do not take advantage of their respective size.

Figure 1- Median mark-up and log of median output by industry

It seems that mark-ups tend to be smaller in industries with a large average firm size, and these industries may indeed be closer to a state of perfect competition, although the heterogeneity of each industry might need a pattern more complex than the one presented in the figures. Besides this, it can be taken as a sign that a high degree of intra-industry competition or a high degree of product differentiation exist, which may lead to a difference in costs and prices, and, therefore, the mark-up level is close to one, i.e. does not allow the exercise of market power by the large firms of the industry. This may be the example of the pastries industry once we are talking about different types of fresh pastry. The same can happen with glass industry, although, if we analyse the correlation between the median mark-up and the establishment size, it appears that the firm size does not have a significant correlation with the mark-up, as we can see in table XXIII in appendix B.4.

The second indicator is the capital intensity. From the capital intensity, some advantages may arise, such as: a) the scale economies, b) an increase in productivity., amongst others. Here, the capital intensity is analysed considering the ratio of the physical stock of capital, measured in thousands of euros, and the number of employees. Half of the 22 industries selected present a capital intensity ratio greater than 50 per cent, and it is curious to see that the industries that present a higher capital intensity are the ones that present, in general, smaller median mark-ups, with the exception of the production of Coffee, as can be seen in table XXIV, shown in appendix B.4. It is important to highlight, for example, the production of Cork, which, exhibits a large capital intensity ratio, shows a median mark-up level closer to one, i.e. there may not exist an advantage in the industry for being intensive in capital. As it happens with establishment size, this indicator appears to have no significant correlation with the mark-up level, as we can see in table XXIV.

These results are in line with such literature as Martins *et. al.* (1996), which analysis these two indicators and concludes that both appear to have no significant link with the mark-up.

Another important indicator may be the research and development at firm level, allowing to study the investment that each firm makes concerning the innovation and differentiation; however, the data do not make available the importance of R&D in the cost structure of the firm. In the same situation there are the entry barriers or the exposure to international competition. Besides the fact that data do not have the export/import ratio, I will make a guess based on the knowledge surrounding the subject. Many firms that compete in international markets hope to gain cost advantages, mainly due to the attainment of economies of scale that lower their production costs. Nevertheless, this kind of industries, that are exposed to international competition, are also exposed to a new set of costumers, but, at the same time, to a higher level of competition and, therefore, mark-ups may be closer to one. Also, the product differentiation influences the results. Besides the fact that external or internal competition may reduce the market power, if we are comparing very different products, the costs and the prices may necessarily be different, e.g. the Wine industry or textile sector.

5.3 Comparison with previous studies

The results were expected since mark-up expresses the power that a firm has to set a price above its marginal cost. Nevertheless, some industries may exhibit a median mark-up lower than 1, e.g. Olive oil, Cork and Manufacture of knitwear clothing, which was not expected and can be odd from an economic point of view, i.e. a firm sells at a price below the cost of the last unit; however, I did not impose any restrictions in order for mark-ups to be larger than one. The results of mark-ups obtained for manufacturing industries range, with some exceptions, from zero to 50 per cent and are, in general, above 15 per cent. These values are substantially lower than the ones reported by Santos *et. al.* (2014), which are, in general, above 20 per cent for the Portuguese manufacturing sector. In broad terms, the difference between these results is primarily due to the adjustment of intermediate inputs. In the results reported by Hall (1988), the significant mark-up ratios are clearly above 100 per cent, which is similar to Roeger's (1995) results for the U.S. manufacturing sector, that range from 15 to 175 per cent. The results presented in this paper are more in line with those of Martins *et. al.* (1996), where the mark-up level ranges between zero to 30 per cent.

5.4 Mark-up and TFP distributions

Besides all these hypothesis, it is important to analyse the distribution of mark-up and TFP distributions, taking into consideration some of the problems presented above.

Table II shows a median mark-up level in each industry. However, there is a large amount of heterogeneity that empirically arises from the shares of inputs to the production function approach, even when we consider similar technologies. Figure 2 depicts the distribution of firm's mark-ups in each industry. The distributions of mark-ups in some of the industries look like a Gaussian distribution[17], e.g. Bakery, Coffee, Kitchen furniture, Metal doors and windows, Milk and dairy products, Moulds, Manufacture of other outwear, Pastries, and Wood furniture. The other industries tend to be more asymmetric, e.g. Manufacture of food for livestock.

From the Kolmogrov-Smirnov non-parametric test, I conclude that, at 5 per cent of significance, results may differ in the shape of distributions presented in Figure 2. This type of behavior is expected since we did not impose any mark-up restrictions to be larger than one, and there are always some measurement errors that are present when the mark-up is smaller than one, as shown in the figure.

Notice that the coefficient of intermediate inputs influences only the median mark-up level. So, even if we had assumed similar technologies across industries, the intermediate input share would still change from one firm or industry to another, i.e. there is a large amount of heterogeneity across industries. However, industries that present more homogeneous products, such as Cork, tend to show less dispersion than

[17] A Kolmogrov-Smirnov test of normality is presented in Table XXV, in appendix B.5.

Bakery or Manufacture of other outwear. Moulds, for instance, present a mark-up distribution that is closer to a state of perfect competition and a long tail of producers with high market power, in an industry where there is not much product differentiation, this being the reason why it is measured by the number of moulds produced. Other examples are the production of olive oil or the manufacture of concrete for building.

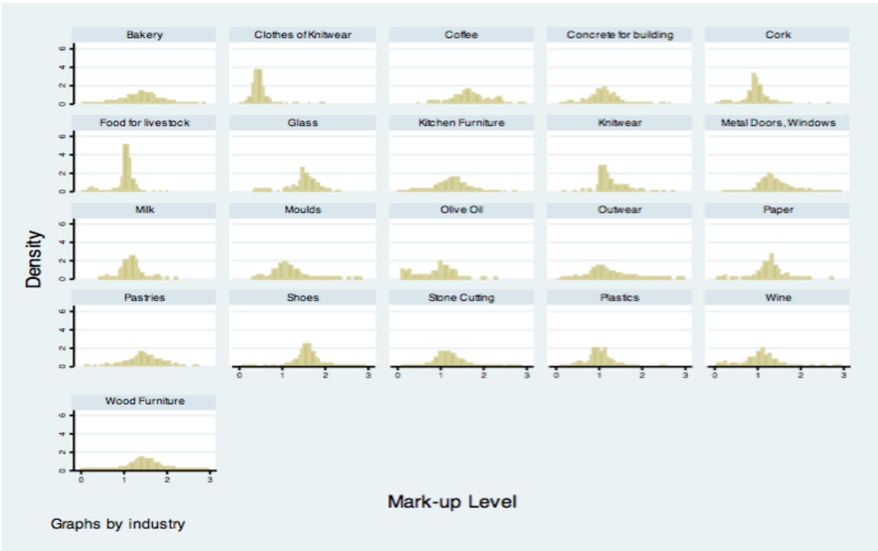

Figure 2- Mark-up Distribution by Firm for Each Industry

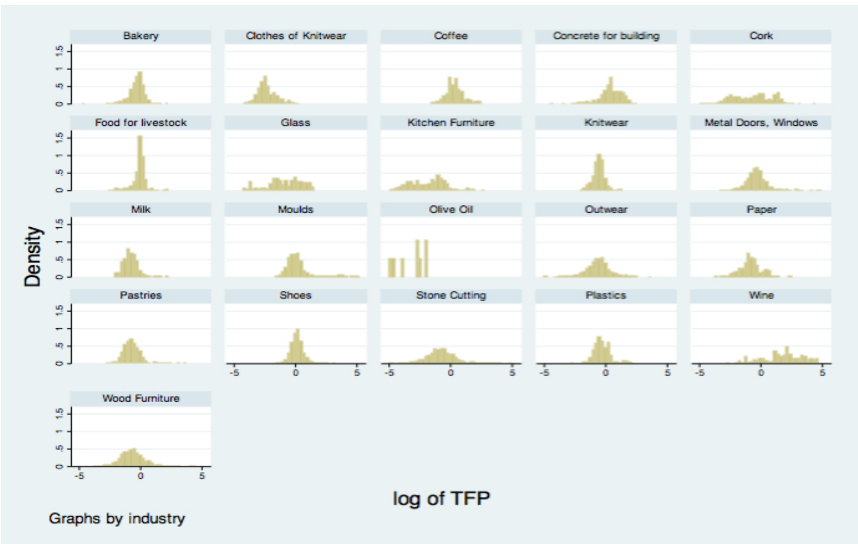

Figure 3- TFP Distribution by Firm each Industry

Figure 3 shows us the firm distribution TFP for each industry. The logarithm of TFP seems to have a Gaussian distribution, which implies a lognormal distribution for TFP levels. As we can observe, there is a significant dispersion of firm TFP across the same industry, e.g. Kitchen furniture. This may happen due to products' heterogeneity within industry, e.g. in the Kitchen furniture industry, the unit considered is the number of pieces used to construct each part of the furniture, meaning one cupboard or one table.

Figures 4 and 5 depict the persistency in mark-up and TFP levels obtained for each firm, i.e. in materials shares across firms in the same industry. Market power measures tend to exhibit a high persistency[18], but not as high as TFP. To analyse the persistency, I present, in Table XXVI, appendix B.5, a formal ADF unit-root test. The null hypothesis tests the correlation between the variable at time t and t-1. As we can see from the results, we cannot reject the existence of a unit root, i.e. there is a correlation of mark-ups between period t and t-1. The same occurs when we consider the TFP. We can observe this in Bakery and Wood furniture, shown in figure 5. The smaller dispersion might be a sign of the fact that the industry may have a more dynamic market structure in more homogeneous industries. This may be an indication that firms compete more with each other in more homogeneous industries and for more homogeneous products. This may also be a sign of the fact that industries which show less dispersion tend to be more competitive. See, for example, Olive oil, which presents a mark-up close to one, in an industry with small product differentiation, since we are talking about the production of litres of olive oil.

[18] In Table XXVI, appendix B.5, we present a formal test of persistency by an ADF Unit Root Test.

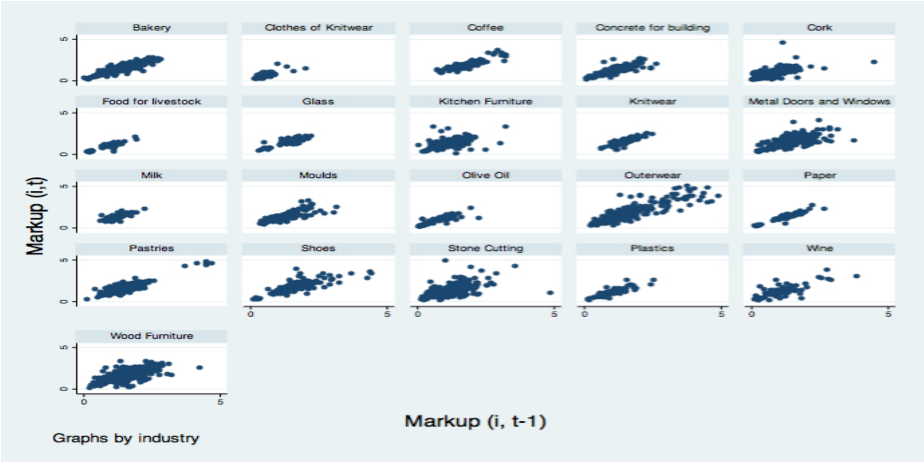

Figure 4- Mark-up Transition by Industry

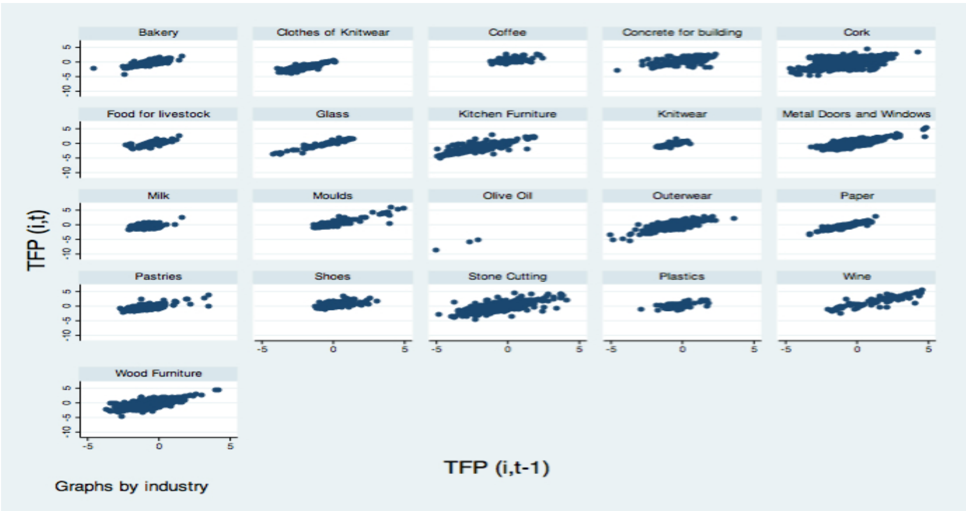

Figure 5- TFP Transition by Industry

6 CYCLICALITY WITH GDP

The cyclicality of mark-ups is one of the topics that raise most interest in macroeconomic literature nowadays[19]. In this section, as a first approximation to the analysis of cyclicality of mark-ups, I analyse it in relation to the logarithm of GDP, which will be followed by a brief study of unconditional cyclicality of mark-ups with prices, quantities, revenues and value added.

[19] See Afonso & Costa (2013), Nekarda & Ramey (2013) and Juessen & Linnemann (2012), amongst others.

Nekarda & Ramey (2013), Rotemberg & Woodford (1999), amongst others, analyse the behavior of mark-ups concerning the GDP, as well as the effect of shocks of supply and demand. Therefore, I assess the cyclicality by computing the correlation of mark-ups with the GDP with fixed effects. The GDP at constant prices was taken from the European Commission AMECO database (1.1.0.0.OVGD).

Table V shows the results of the following equation:

(12) $$\mu_{it} = \beta_t \ln GDP_t + \theta_i + \gamma_{it}$$

where θ_i represents firm's dummies.

TABLE V Mark-up Regression with GDP: Estimated Values in eq. (12)

	Sample		Whole economy	
	Coef.	s. e.	Coef.	s. e.
ln(GDP)	-0.484***	0.13	-0.10***	0.03
Constant	3.89***	0.59	2.19***	0.12
R-Squared	0.002		0.04	
Prob>F	0.000		0.000	
Observations	16285		1438911	
Firms	4299		364528	

Source: Author's computation
Notes: The sample results are for the selected industries. In the whole economy the dependent variable is the inverse of the input share for materials and the whole census data is used.
*** significant at 1 per cent

As we can see in Table V, the market power measure tends to have a negative correlation with the GDP log. This is also true for the whole economy, which represents the whole set of firms presented in the IES. Our results are similar to the ones that are presented in the literature, e.g. Santos *et al.* (2014). Considering other assesses of the unconditional cyclicality, I compute the correlation of mark-ups with prices, quantities, revenues and value added.

The results shown in Table VI, are obtained through the following equation:

(13) $$\ln \mu_{it} = \beta_t \ln \omega_{it} + \theta_i + \gamma_{it}$$

where $\omega = q, Y, VA, p$.

TABLE VI Mark-up regressions: Estimated Values in eq. (13)

	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.	Coef.	s.e.
ln(q)	-0.028***	0.004														
ln(Y)			0.007***	0.008												
ln(VA)					-0.171***	0.005										
ln(p)							0.002***	0.001								
Δ *ln(q)*									-0.004***	0.001						
Δ *ln(Y)*											0.013	0.011				
Δ *ln(VA)*													-0.017	0.007		
Δ *ln(p)*															0.006	0.003
R-Squared	0.002		0.001		0.091		0.139		0.000		0.002		0.000		0.001	
Prob>F	0.000		0.009		0.000		0.000		0.7998		0.025		0.014		0.018	
Observations	15223		15605		15409		14441		10146		10932		10837		10101	
Firms	4069		4101		4070		3902		3088		3249		3233		3072	

Source: Author's Computation

Notes: ***,**,* denotes statiscally significant at 1,5 and 10 per cent level, respectively

q represents quantities, Y stands for revenues, VA stands for Value-Added; p represents prices

Concerning the results in Table VI, we can see that the mark-up is positively correlated to prices and negatively to quantities. This was expected since demand functions are downward slopping. The results of both tables are as expected. Rotemberg & Woodford (1999), for example, use the evidence on the pro-cyclical behavior of input factors to conclude that average mark-ups are unconditionally countercyclical, although the pro-cyclical behavior of inputs itself does not guarantee the counter-cyclicality of mark-ups with GDP. A deeper analysis is necessary concerning the supply and demand shocks, even more when the mark-up depends not on input utilization but on the share of one input, in this case an intermediate input. Nonetheless, this is a preliminary indication of the fact that mark-ups tend to be countercyclical with shocks that affect the GDP. Also, as explained by many authors, namely Rotemberg & Woodford (1999), mark-up variations contribute to output movements, even if these are independent from the real marginal cost shift and even if there is a negative correlation between them. This relation between output and mark-ups plays an important role, mostly due to effects concerning shocks, as for example the technology shocks. If those shocks induce countercyclical markup variations, this will further amplify their effects upon the output, in addition to the effects that come from marginal cost variations. The argument for value-added and revenues is the same as for output, and the correlation between them and mark-ups is also negative. Hall (2009) for instance, presents a point of view stating that models where mark-up falls when output expands are due to sticky prices of products.

From a policy point of view, the cyclicality of mark-ups is largely influenced by the effectiveness of the economics policy. For these reasons, some shocks are identified by the literature mainly due to productivity, taxation, government spending, amongst others. Nowadays, there is a renewed interest in the effects of fiscal policy, which resulted in a series of papers (e.g. Afonso & Costa (2013)); this is also true for government-spending (e.g. Hall(2009))

New Keynesisan synthesis models produced undesired endogenous mark-ups due to nominal rigidity, highlighting the effectiveness of demand-side policy when compared to real business cycle models, as explained by Afonso & Costa (2013) or Rotemberg & Woodford (1999). Goodfriend & King (1997), analyse the neoclassical synthesis and the role of monetary policy and conclude that mark-ups are counter-cyclical mainly due to nominal rigidity and to the costly dynamic of prices adjustment. Therefore, it occurs that mark-up reduction arises with an increase in ouput. Concerning government spending, Hall (2009) presents a point-of-view stating that there is an increase in total output when the government buys more goods and services.

When we consider the case of desired mark-ups, see for example Ravn *et al.* (2006), that relates productivity shocks in the presence of fiscal shocks.

To sum up, the theoretical literature on mark-ups is largely dominated by the idea that mark-ups behave pro-cyclically with supply shocks and counter-cyclically with demand shocks.

7 CONCLUSION

This dissertation aims to provide new insights on the estimation of mark-up levels in Portuguese manufacturing industries by using a plant rich price and quantity data, where information on prices allows estimating production function in quantities instead of revenues. The first conclusion is that the former approach produces higher mark-ups than the latter.

I used a GMM approach that combines quantities, labour, physical stock of capital, or intermediate inputs, and lags of the variables as instruments. Due to the fact the optimal choice of inputs may lead to an input-endogeneity problem, I presented a new way of estimating the production function under mild assumptions for the productivity stochastic process, based upon the recent work of Santos *et al.* (2014).

The analysis for 21 manufacturing industries using single-product firms in the period of 2004-2010 shows that, price-marginal cost ratios are substantially larger than one in general, usually above 15 per cent.

I have also conducted an empirical analysis of mark-up (and TFP) distributions for each industry and I provide some explanations about the mark-up level. The main conclusion in this front is that there is a large amount of heterogeneity amongst firms and industries. Furthermore, industries that show less dispersion, tend to more competitive.

Finally, I study the unconditional cyclicality of mark-up with respect to GDP, prices, quantities, revenues and value added. I conclude that mark-ups tend to be countercyclical with GDP, quantities, revenues and value added, and procyclical with prices.

Considering the mark-ups are generally accepted to be procyclical with supply (i.e. TFP) shocks, the evidence here tends to favour the vision that mark-ups may be countercyclical with demand shocks. However, I cannot advance that conclusion since I did not identify demand shocks separately in order to perform a condition cyclicality analysis.

In terms o future research, this dissertation opens the door to continue a detailed study on mark-ups in Portugal, with different production functions, less restrictive assumptions, and also for multi-product firms, especially using a cost-function approach.

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APPENDIX

A.1 Sample Selection

TABLE VII Number of firms per year for the IES database

Year	Firms
2004	321.446
2005	332.030
2006	351.599
2007	350.442
2008	350.797
2009	349.535
2010	360.062
Total	2.415.911

Source: Author's Computation

TABLE VIII Number of products and firms per year for the IAPI database

Year	Products	Firms
2004	45.392	8.861
2005	49.631	9.556
2006	52.748	9.565
2007	48.568	8.805
2008	43.891	8.239
2009	40.327	8.574
2010	39.378	8.518
Total	319.935	62.118

Source: Author's Computation

TABLE IX Number of firms by number of products reported (IAPI database)

Number of Products	Firms	%
1	40.682	26%
2	31.917	20%
3	14.264	9%
4	18.671	12%
5	7.139	4%
6+	45.355	29%

Source: Author's Computation

TABLE X Number of firms per year for total sample

Year	Merged Sample	Usable Sample
2004	55.275	52.734
2005	53.509	50.782
2006	61.049	56.437
2007	55.528	51.812
2008	50.334	46.882
2009	49.333	44.195
2010	49.741	45.439
Total	371.769	348.281

Source: Author's Computation
The usable sample excludes observations with missing values for the output or inputs.

TABLE XI Number of firms per year per industry from the IAPI database, merged and usable sample

CAE 2.1	Industry	Total IAPI SAMPLE	Merged Sample	Usable Sample
15811	Bakery	1.305	978	924
10830	Coffee	261	174	163
15860	Cork	1.486	1.459	1.443
26120	Glass	160	158	156
36130	Kitchen Furniture	811	678	649
17720	Manufacture of clothes of Mesh(camisolas)	768	522	516
26610	Manufacture of concrete for building	723	648	631
15710	Manufacture of Food for livestock	419	402	399
17600	Manufacture of knitwear(tecido de malha)	541	421	413
18221	Manufacture of other outerwear	1.072	953	932
21211	Manufacture of paper	214	186	181
25210	Manufacture of plastic plates, sheets, tubes	358	279	272
28120	Metal Doors, Windows	2.397	1.961	1.930
15510	Milk and dairy Products	670	305	283
29563	Moulds	903	899	888
15412	Olive Oil	689	338	287
15812	Pastries	1.291	877	801
19301	Shoes	1.735	1.623	1.554
26701	Stone Cutting	2.097	2.048	2.032
15931	Wine	419	317	224
36141	Wood Furniture	2.349	2.148	2.078
Total		20.668	17.374	15.019
% in total usable sample (Table X)		5.9%	5%	4.3%

Source: Author's Computation
Number of firms per industry. The usable sample excludes observations with missing values for the output or inputs

TABLE XII Single-product firms versus multi-product firms - summary statistics

Industry	Single-Product Firms								Multi-Product Firms							
	Y		Q		L		K		Y		Q		L		K	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Bakery	570.096	2.020.086	174.768	573.816	14	14	274.828	635.760	359.664	120.098	68.457	412.265	41	92	560.994	1.150.042
Coffee	8.743.666	20.300.000	325.398	1.392.501	58	91	3.823.548	7.053.134	11.000.000	47.200.000	209.811	875.158	62	135	6.926.384	22.900.000
Cork	6.395.555	17.500.000	912.136	3.690.630	43	112	2.587.670	8.434.804	5.517.249	14.700.000	705.209	2.822.045	37	96	2.861.611	9.313.423
Glass	1.301.686	1.590.795	364.523	474.557	24	21	911.151	1.535.551	3.651.173	9.003.006	347.862	1.107.558	32	39	2.597.844	5.846.366
Kitchen Furniture	1.089.276	1.654.814	4.302	12.960	19	19	620.195	1.040.019	1.036.249	2.699.448	2.853	12.748	18	21	763.738	1.340.925
Manufacture of clothes of knitwear	1.604.724	3.057.215	78.850	226.650	47	66	1.345.500	1.718.347	1.507.711	2.810.600	54.675	159.974	49	68	2.298.148	3.081.979
Manufacture of concrete for building	4.301.988	5.283.189	19.100.000	21.400.000	47	53	3.745.518	4.802.301	4.798.976	8.964.125	16.400.000	23.200.000	54	79	5.523.655	6.348.762
Manufacture of Food for livestock	1.450.000	18.500.000	5.109.083	11.900.000	43	46	2.395.358	3.012.176	18.200.000	46.900.000	4.607.382	9.392.064	47	56	5.001.455	6.837.965
Manufacture of knitwear	3.995.565	4.383.896	686.278	860.412	28	34	1.244.558	1.734.373	3.788.484	4.294.146	706.526	894.146	31	42	2.755.304	4.306.142
Manufacture of other Outwear	2.772.172	4.193.636	31.307	93.674	90	99	1.058.943	1.693.317	3.417.166	5.873.124	20.914	68.589	72	89	1.861.328	3.300.472
Manufacture of paper	8.540.734	13.000.000	6.754.946	10.300.000	60	73	3.961.733	5.959.000	10.300.000	14.300.000	8.556.978	11.800.000	81	89	11.300.000	17.400.000
Manufacture of Plastics	1.120.000	14.100.000	2.967.784	5.403.135	57	48	4.277.645	5.208.185	12.000.000	22.000.000	2.262.985	4.801.749	67	93	8.145.023	10.600.000
Metal Doors and Windows	1.196.086	2.324.446	5.788	58.391	18	20	417.074	661.221	1.163.120	1.860.959	3.469	45.536	19	20	608.883	936.604
Milk and dairy Prodcuts	1.515.787	1.337.538	141.047	200.638	18	16	1.051.993	1.354.648	14.500.000	64.300.000	784.853	4.566.088	62	175	8.681.429	29.100.000
Moulds	3.687.018	3.387.658	1.184	9.826	49	34	3.239.601	3.894.028	3.190.084	5.915.054	4.312	30.428	44	47	3.963.537	5.206.741
Olive Oil	2.972.863	7.360.585	1.007.925	2.507.577	12	13	1.596.943	3.709.526	1.816.830	7.842.231	366.214	1.369.782	7	10	1.315.101	2.281.814
Pastries	662.754	1.745.071	63.102	213.783	17	19	279.324	463.052	467.794	1.763.810	686.278	2.854.354	18	18	2.587.670	412.265
Shoes	5.034.274	6.133.796	116.400	241.683	89	92	1.292.836	2.595.294	5.182.165	11.100.000	6.090.244	147.692	85	114	2.633.474	5.435.552
Stone Cutting	1.159.836	1.494.741	1.826.119	4.853.619	19	18	995.621	1.691.083	1.405.008	2.056.787	1.917.668	5.503.602	22	27	1.844.158	2.663.364
Wine	2.977.584	5.819.246	721.292	1.661.508	13	13	2.045.639	4.429.089	6.916.979	16.700.000	1.015.918	2.735.411	38	74	7.637.283	16.700.000
Wood Furniture	1.198.101	2.855.353	5.259	83.074	29	38	820.128	3.760.442	1.109.779	2.110.188	194.065	10.952	29	35	1.085.806	1.753.251

Source: Author's computation

Y represents revenues, Q stands for quantities produced, L stands for labour, K represents physical stock of capital

A.2 Construction of Physical Stock of Capital

The depreciation rate for manufacturing industries for the construction of the physical capital stock follows

$$\delta = (GFCF - (K_t - K_{t-1}))/(K_{t-1})$$

The variables were taken from European Comission AMECO Database (codes in brackets) and correspond to: K_t – Net Capital Stock at 2005 prices (1.0.0.0.OKND); $GFCF$ - Gross fixed capital formation (1.1.0.0.OIGT). The annual depreciation rate is about 6.3%.

B.1 OLS Results and Figures

TABLE XIII OLS Estimations for quantities: Median mark-up obtained using the labour share without intermediate inputs

Industry	RtS	α	β	Median Markup
Bakery	1.122	0.169	0.953	2.842
Coffee	1.161	0.336	0.825	3.713
Cork	0.909	0.297	0.612	16.810
Kitchen Furniture	1.338	0.161	1.177	5.012
Manufacture of clothes of knitwear	0.942	-0.104	1.046	3.351
Manufacture of concrete for building	0.963	0.598	0.365	2.193
Manufacture of Food for livestock	0.982	0.369	0.613	14.803
Manufacture of glass	1.078	0.444	0.634	2.563
Manufacture of knitwear	0.749	0.038	0.711	9.185
Manufacture of other Outwear	0.408	0.390	0.018	0.069
Manufacture of paper	1.309	0.034	1.275	8.902
Manufacture of Plastics	1.179	0.648	0.531	4.432
Metal Doors and Windows	1.039	0.141	0.897	4.122
Milk and dairy Prodcuts	1.323	0.315	1.008	8.509
Moulds	0.460	-0.084	0.545	2.392
Olive Oil	0.870	0.571	0.299	19.635
Pastries	1.088	0.225	0.863	2.827
Shoes	1.053	0.297	0.755	4.110
Stone Cutting	0.925	0.391	0.534	2.436
Wine	0.737	-0.102	0.839	12.801
Wood Furniture	1.189	0.155	1.034	3.744

Source: Author's computation

Notes: OlS estimations for markups obtained through labour share, wihout intermediate inputs and quantities as dependent variable

TABLE XIV OLS Estimations for Value Added: Median Mark-up obtained using the labour share without intermediate inputs

Industry	RtS	α	β	Median Markup
Bakery	1.136	0.128	1.008	3.005
Coffee	1.198	0.319	0.879	3.957
Cork	0.965	0.184	0.781	21.442
Kitchen Furniture	1.139	0.080	1.059	4.510
Manufacture of clothes of knitwear	1.017	0.047	0.970	3.108
Manufacture of concrete for building	1.094	0.224	0.870	5.228
Manufacture of Food for livestock	1.013	0.228	0.785	18.943
Manufacture of glass	0.893	0.109	0.784	3.172
Manufacture of knitwear	0.939	0.154	0.785	10.133
Manufacture of other outwear	0.944	0.101	0.844	3.176
Manufacture of paper	1.231	0.260	0.971	6.777
Manufacture of Plastics	1.212	0.126	1.086	9.069
Metal Doors and Windows	1.120	0.104	1.016	4.667
Milk and dairy Prodcuts	1.112	0.187	0.925	7.811
Moulds	1.040	0.136	0.904	3.971
Olive Oil	0.928	0.476	0.452	29.665
Pastries	1.170	0.111	1.059	3.470
Shoes	0.992	0.119	0.873	4.749
Stone Cutting	0.986	0.197	0.789	3.599
Wine	0.935	-0.220	1.155	17.618
Wood Furniture	1.015	0.153	0.862	3.123

Source: Author's computation.
Notes: OlS estimations for markups obtained through labour share, wihout intermediate inputs and Value Added as dependent variable

TABLE XV OLS Estimations for Revenues: Median mark-up obtained using the labour share without intermediate inputs

Industry	RtS	α	β	Median Markup
Bakery	0.880	0.182	0.698	2.080
Coffee	0.944	-0.246	1.190	5.359
Cork	0.681	0.224	0.457	12.545
Kitchen Furniture	1.188	0.225	0.963	4.101
Manufacture of clothes of knitwear	0.609	-0.174	0.782	2.506
Manufacture of concrete for building	0.964	0.418	0.545	3.275
Manufacture of Food for livestock	0.457	0.342	0.116	2.791
Manufacture of glass	1.118	0.350	0.768	3.107
Manufacture of knitwear	0.857	0.079	0.777	10.039
Manufacture of other Outwear	0.602	0.341	0.261	1.754
Manufacture of paper	0.745	-0.306	1.051	7.339
Manufacture of Plastics	0.836	0.803	0.033	0.272
Metal Doors and Windows	0.994	0.191	0.804	3.692
Milk and dairy Prodcuts	1.182	0.406	0.775	6.547
Moulds	0.883	0.181	0.701	3.080
Olive Oil	0.977	0.761	0.216	14.180
Pastries	0.785	0.376	0.409	1.339
Shoes	0.945	0.221	0.724	3.942
Stone Cutting	0.498	0.248	0.249	1.138
Wine	0.564	-0.263	0.827	12.614
Wood Furniture	0.885	0.175	0.710	2.573

Source: Author's computation;
Notes: OlS estimations for markups obtained through labour share, wihout intermediate inputs and revenues as dependent variable

TABLE XVI OLS Estimations for Quantities: Median mark-up obtained using both labour and intermediate inputs shares

Industry	RtS	α	β	δ	Median Markup - Intermediate Shares	Median Markup - Labour Share
Bakery	1.113	0,084	0.690	0.340	2.056	0.649
Coffee	0.939	0,036	-0.180	1.083	-0.809	1.929
Cork	0.983	0,143	0.029	0.811	0.799	1.083
Kitchen Furniture	1.209	0,121	0.535	0.553	2.280	0.869
Manufacture of clothes of knitwear	0.965	-0,117	0.309	0.774	0.988	1.483
Manufacture of concrete for building	0.960	0,574	0.290	0.096	1.743	0.137
Manufacture of Food for livestock	1.060	-0,008	-0.124	1.191	-2.996	1.357
Manufacture of glass	1.017	0,354	0.096	0.567	0.387	0.919
Manufacture of knitwear	0.885	0,025	-0.192	1.052	-2.475	1.300
Manufacture of other Outwear	0.885	-0,043	0.159	0.769	1.065	2.238
Manufacture of paper	1.204	-0,076	0.508	0.773	3.545	1.039
Manufacture of Plastics	0.872	0,091	-0.254	1.036	-2.124	1.433
Metal Doors and Windows	1.008	0,052	0.166	0.790	0.763	1.214
Milk and dairy Prodcuts	1.117	0,041	0.206	0.870	1.743	1.164
Moulds	0.461	-0,117	0.446	0.132	1.957	0.310
Olive Oil	0.712	0,240	0.007	0.465	0.443	0.773
Pastries	1.068	-0,034	-0.046	1.148	-0.149	1.984
Shoes	1.021	0,063	0.082	0.876	0.447	1.296
Stone Cutting	1.044	0,175	0.118	0.752	0.538	1.238
Wine	0.929	0,026	-0.086	0.989	-1.316	1.491
Wood Furniture	1.162	-0,011	0.442	0.731	1.602	1.299

Source: Author's computation;
Notes: OlS estimations for markups obtained through labour share and intermediate inputs share and quantities as dependent variable

TABLE XVII OLS Estimations for Value Added: Median Mark-up obtained using both labour and intermediate inputs shares

Industry	RtS	α	β	δ	Median Markup - Intermediate Shares	Median Markup - Labour Share
Bakery	1.128	0.054	0.772	0.303	2.301	0.578
Coffee	1.084	0.187	0.378	0.519	1.701	0.926
Cork	0.994	0.122	0.564	0.308	15.472	0.412
Kitchen Furniture	1.048	0.051	0.608	0.390	2.589	0.613
Manufacture of clothes of knitwear	1.028	0.042	0.642	0.344	2.058	0.658
Manufacture of concrete for building	1.083	0.124	0.536	0.423	3.217	0.604
Manufacture of Food for livestock	1.061	0.043	0.519	0.500	12.527	0.569
Manufacture of glass	0.809	-0.016	0.043	0.782	0.174	1.266
Manufacture of knitwear	1.016	0.181	0.336	0.499	4.341	0.616
Manufacture of other Outwear	0.983	0.082	0.660	0.241	4.429	0.700
Manufacture of paper	1.192	0.208	0.686	0.298	4.791	0.401
Manufacture of Plastics	1.105	-0.063	0.814	0.354	6.794	0.490
Metal Doors and Windows	1.105	0.062	0.661	0.382	3.035	0.588
Milk and dairy Prodcuts	0.999	0.060	0.525	0.414	4.432	0.554
Moulds	1.040	0.064	0.739	0.237	3.247	0.556
Olive Oil	0.826	0.281	0.269	0.276	17.693	0.458
Pastries	1.161	0.013	0.710	0.438	2.327	0.757
Shoes	0.974	0.045	0.627	0.302	3.412	0.447
Stone Cutting	1.047	0.094	0.581	0.372	2.654	0.612
Wine	1.038	-0.105	0.460	0.683	7.013	1.029
Wood Furniture	1.004	0.056	0.531	0.418	1.921	0.742

Source: Author's computation;
Notes: OLS estimations for markups obtained through labour share and intermediate inputs share and value added as dependent variable

TABLE XVIII OLS Estimations for Revenues: Median mark-up obtained using both labour and intermediate inputs shares

Industry	RtS	α	β	δ	Median Markup - Intermediate Shares	Median Markup - Labour Share
Bakery	0.874	0.114	0.484	0.276	1.442	0.528
Coffee	0.835	-0.393	0.699	0.529	3.147	0.944
Cork	0.752	0.067	-0.148	0.833	-4.067	1.113
Kitchen Furniture	1.090	0.194	0.475	0.420	2.025	0.661
Manufacture of clothes of knitwear	0.634	-0.188	-0.013	0.835	-0.042	1.599
Manufacture of concrete for building	0.946	0.325	0.196	0.425	1.178	0.606
Manufacture of Food for livestock	0.513	0.078	-0.416	0.852	-10.051	0.970
Manufacture of glass	1.058	0.262	0.246	0.550	0.996	0.891
Manufacture of knitwear	1.019	0.024	-0.119	1.115	-1.539	1.378
Manufacture of other Outwear	0.763	-0.044	0.136	0.671	0.914	1.954
Manufacture of paper	0.676	-0.378	0.536	0.519	3.739	0.697
Manufacture of Plastics	0.519	0.227	-0.779	1.071	-6.506	1.482
Metal Doors and Windows	0.954	0.071	-0.168	1.051	-0.773	1.615
Milk and dairy Prodcuts	1.017	0.187	0.136	0.694	1.147	0.929
Moulds	0.903	-0.061	0.188	0.776	0.826	1.822
Olive Oil	0.792	0.398	-0.201	0.595	-13.198	0.990
Pastries	0.761	0.061	-0.691	1.391	-2.265	2.404
Shoes	0.921	0.045	0.221	0.656	1.204	0.970
Stone Cutting	0.671	-0.029	-0.303	1.004	-1.385	1.652
Wine	0.721	-0.181	0.199	0.703	3.033	1.059
Wood Furniture	0.865	0.006	0.125	0.734	0.453	1.304

Source: Author's computation;
Notes: OLS estimations for markups obtained through labour share and intermediate inputs share and revenues as dependent variable

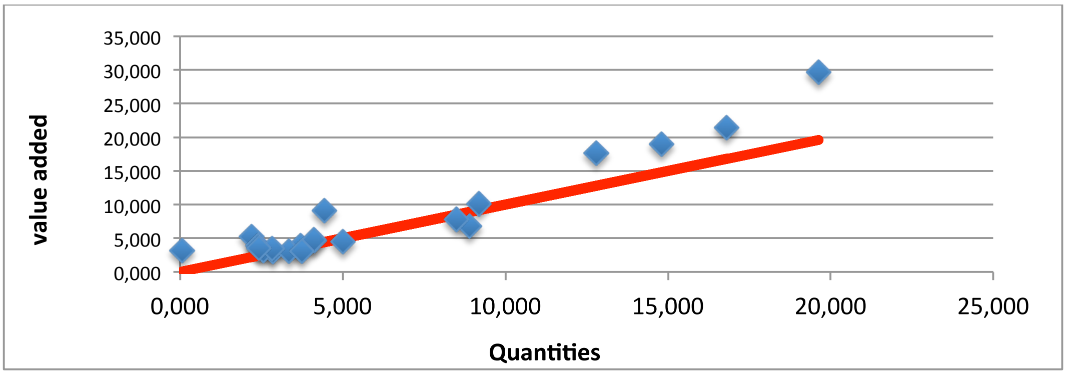

Figure 6- Mark-ups estimated with CD production function, from labour share, no materials

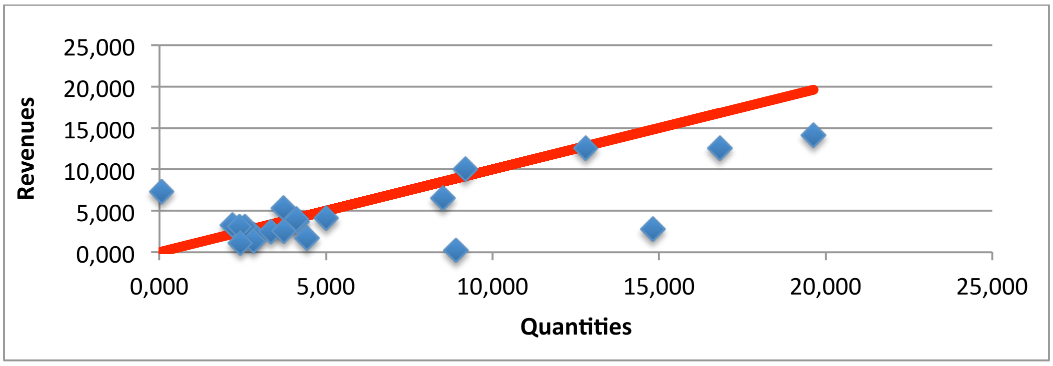

Figure 7- Mark-ups estimated with CD production function, from labour share, no materials

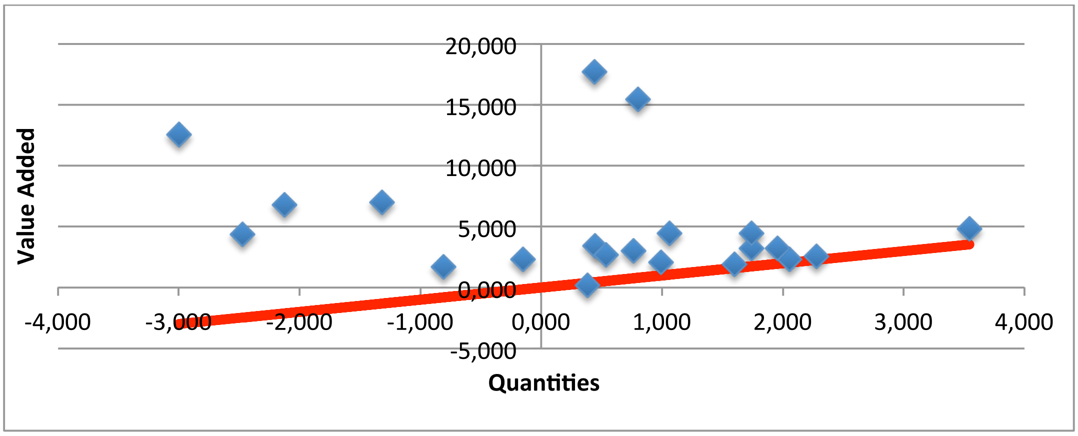

Figure 8- Mark-ups estimated with CD production function, from labour share, with intermediate inputs

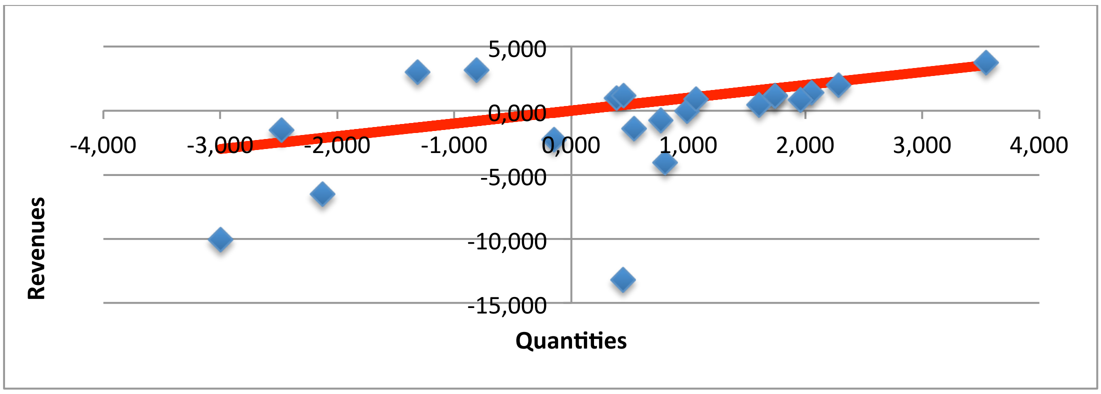

Figure 9- Mark-ups estimated with CD production function, from labour share, with intermediate inputs

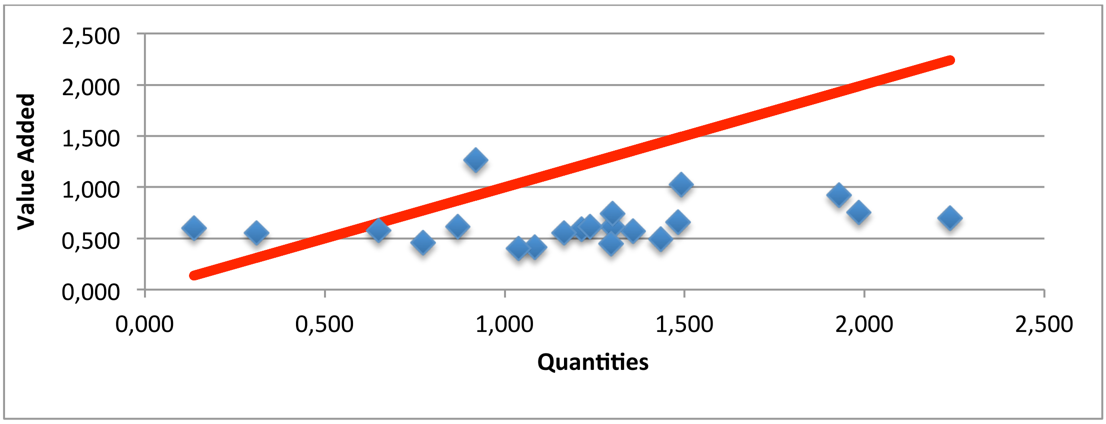

Figure 10- Mark-ups estimated with CD production function, from materials share, with intermediate inputs

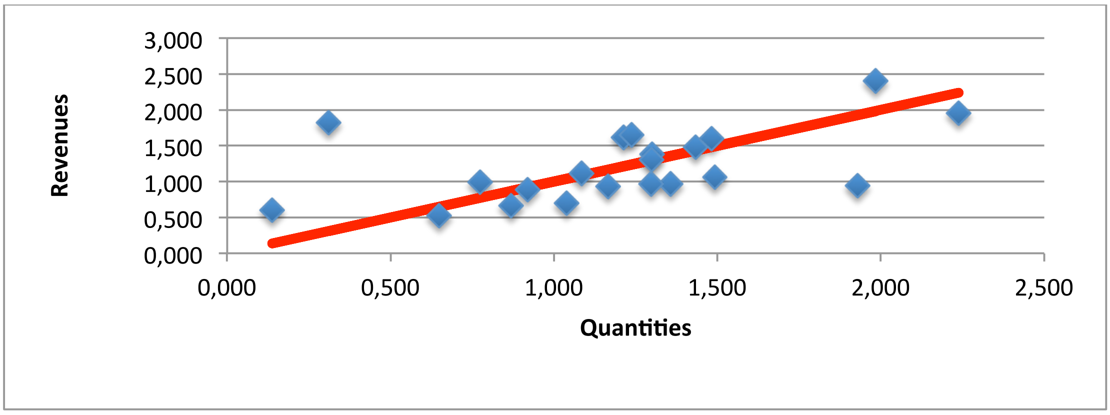

Figure 11- Mark-ups estimated with CD production function, from materials share, with intermediate inputs

B.2 GMM Coefficients

TABLE XIX Coefficients of GMM Estimation

	Linear Approximation				Cubic Approximation					
Industry	**δ**	**β**	**α**	**g1**	**δ**	**β**	**α**	**g1**	**g2**	**g3**
Bakery	0.801***	0.108	0.000	0.807***	0.659***	0.312	0.000	0.716	-0.043	-0.014***
	(0.110)	(0.113)	(0.001)		(0.166)	(0.234)	(0.001)			
Coffee	1.077***	-0.166	0.001	0.443	0.642***	0.737***	-0.006***	1 092	0.369	0.079
	(0.091)	(0.152)	(0.002)		(0.078)	(0.141)	(0.002)			
Cork	0.785***	0.256	-0.001	0.578	0.890***	0.222	-0.003	0.467	-0.003***	0.006
	(0.171)	(0.161)	(0.003)		(0.238)	(0.253)	(0.004)			
Glass	0.949***	0.172	0.002	0.990	0.622**	0.994***	0.008***	-3 169	-0.273	0.010
	(0.060)	(0.232)	(0.002)		(0.250)	(0.359)	(0.003)			
Kitchen Furniture	0.915	0.405	0.005	0.897***	1.042	0.241	0.004	0.892	0.001***	0.000
	(0.564)	(0.488)	(0.004)		(1.026)	(1.207)	(0.005)			
Manufacture of Clothes of Knitwear	0.223	0.570***	0.002	0.958	0.622**	0.690***	0.003**	4.178***	0.400	0.028***
	(0.276)	(0.187)	(0.001)		(0.063)	(0.115)	(0.001)			
Manufacture of Concrete for Buildings	0.786***	0.137	-0.004***	0.698	0.846***	0.009	-0.004*	0.692	-0.009	0.003
	(0.158)	(0.208)	(0.002)		(0.182)	(0.261)	(0.002)			
Manufacture of Food for Livestock	1.006***	0.046	-0.001	0.725	0.942***	0.015	0.002**	0.119	-0.074***	0.009
	(0.063)	(0.077)	(0.002)		(0.026)	(0.026)	(0.001)			
Manufacture of Knitwear	0.907***	-0.008	0.003*	0.960	0.881***	0.009	0.003*	0.130	-0.299***	-0.066***
	(0.089)	(0.064)	(0.002)		(0.100)	(0.148)	(0.002)			
Manufacture of Outerwear	0.544***	0.082	0.002	0.713***	0.531***	0.159*	0.001	0.788	0.035	0.005
	(0.081)	(0.075)	(0.002)		(0.085)	(0.085)	(0.002)			
Manufacture of Paper	0.984***	0.343**	-0.002	0.905	1.062***	0.253	-0.002	0.844***	0.044	0.019
	(0.184)	(0.170)	(0.002)		(0.160)	(0.209)	0.002			
Manufacture of Plastics	0.823***	-0.060	0.002	0.742	1.134***	-0.230	0.008**	1 297	-0.031	-0.027
	(0.162)	(0.152)	(0.002)		(0.169)	(0.156)	(0.003)			
Metal Doors and Windows	0.889***	0.023	0.002	0.727***	0.689***	0.317	-0.002	0.747	0.023***	0.000
	(0.206)	(0.202)	(0.002)		(0.177)	(0.216)	(0.002)			
Milk and Dairy Products	0.918***	-0.006	0.005**	0.368	0.936***	-0.019	0.004**	0.073	0.064	0.005
	(0.083)	(0.091)	(0.002)		(0.094)	(0.110)	(0.002)			
Moulds	0.409***	0.204	-0.006***	0.993	0.588***	0.166	-0.006***	0.752	0.057***	0.005
	(0.196)	(0.152)	(0.002)		(0.136)	(0.175)	(0.002)			
Olive Oil	0.921***	0.293***	0.035***	0.969	0.729***	0.073***	0.013***	1.86***	-0.075	-0.023***
	(0.068)	(0.038)	(0.002)		(0.027)	(0.022)	(0.001)			
Pastries	0.965***	0.039	0.004**	0.661***	0.984***	0.010	0.003	0.979	0.056	-0.018
	(0.113)	(0.096)	(0.002)		(0.186)	(0.172)	(0.003)			
Shoes	1.008***	0.027	-0.002	0.692***	0.857***	0.201	-0.001	0.580	-0.020	0.009
	(0.083)	(0.111)	(0.001)		(0.095)	(0.138)	(0.001)			
Stone Cutting	0.728***	0.159	0.002	0.822	0.767***	0.220	0.001	0.801	0.000	0.001
	(0.138)	(0.119)	(0.003)		(0.148)	(0.275)	(0.004)			
Wine	0.821**	-0.167	-0.009	0.960	0.744*	0.055	-0.011	0.965	-0.007	0.001
	(0.396)	(0.278)	(0.007)		(0.448)	(0.824)	(0.010)			
Wood Furniture	0.882***	0.098	0.002	0.713***	0.623***	0.568*	0.002	0.980***	-0.006	-0.005***
	(0.094)	(0.080)	(0.002)		(0.178)	(0.312)	(0.002)			

Source: Author's computation

Note: denotes the coefficients and the standard erros in parentheses from the estimation of eq. (1) ;

*, **,*** denotes statistically significant at a 1, 5 and 10 per cent level, respectively

B.3 GMM Results

TABLE XX GMM Estimations Median mark-up: obtained using the labour share

TFP transition	Linear Approximation					Cubic Approximation				
Industry	RtS	δ	β	α	Median Markup	RtS	δ	β	α	Media n
Bakery	0.926	0.733	0.193	0.000	0.474	1.023	0.701	0.323	0.000	0.793
Coffee	0.948	1.150	-0.202	0.000	-0.761	0.888	1.346	-0.457	-0.001	-1.723
Cork	1.046	0.801	0.245	0.000	1.766	1.086	0.795	0.292	-0.002	2.103
Glass	1.144	0.907	0.235	0.002	0.842	1.624	0.622	0.994	0.008	3.566
Kitchen Furniture	1.296	0.744	0.546	0.006	1.859	1.288	1.042	0.241	0.004	0.820
Manufacture of clothes of knitwear	0.960	0.492	0.466	0.001	1.232	1.159	0.454	0.703	0.002	1.858
Manufacture of concrete for building	1.057	0.822	0.240	-0.004	1.080	0.866	1.119	-0.251	-0.002	-1.131
Manufacture of Food for livestock	1.036	1.047	-0.010	-0.001	-0.151	0.976	1.047	-0.072	0.001	-1.094
Manufacture of knitwear	0.967	1.003	-0.036	0.001	-0.367	1.044	0.940	0.103	0.001	1.043
Manufacture of other outwear	0.578	0.562	0.015	0.002	0.038	1.799	1.389	0.410	0.000	1.067
Manufacture of paper	0.902	0.360	0.541	0.001	3.022	1.314	1.062	0.253	-0.002	1.414
Manufacture of Plastics	0.691	0.798	-0.113	0.005	-0.657	0.540	1.427	-0.893	0.006	-5.208
Metal Doors and Windows	0.880	0.654	0.222	0.004	0.879	0.962	0.600	0.360	0.002	1.425
Milk and dairy Products	0.967	0.988	-0.024	0.003	-0.171	0.962	1.017	-0.057	0.003	-0.407
Moulds	0.599	0.413	0.190	-0.004	0.507	0.551	-0.174	0.727	-0.002	1.942
Olive Oil	0.730	0.935	-0.199	-0.006	-1.596	0.988	0.776	0.209	0.003	1.676
Pastries	0.973	0.793	0.177	0.002	0.455	1.029	1.050	-0.022	0.001	-0.057
Shoes	0.927	0.648	0.279	0.000	1.223	0.916	0.923	-0.006	-0.001	-0.025
Stone Cutting	0.940	0.700	0.237	0.002	0.836	1.023	1.019	0.004	0.000	0.013
Wine	0.522	0.673	-0.140	-0.012	-0.686	1.682	0.892	0.809	-0.019	3.976
Wood Furniture	0.949	0.773	0.173	0.003	0.509	1.245	0.555	0.688	0.002	2.021

Source: Author's computation

Note: The set of instruments is level of capital stock and intermediate inputs with linear terms (for linear approximation), quadratic and cubic terms (for cubic approximation) of all variables lagged one period

TABLE XXI GMM Estimations: Median mark-up obtained using the labour share (without intermediate inputs)

TFP transition	Linear Approximation				Cubic Approximation			
Industry	RtS	β	α	Median Markup	RtS	β	α	Median Markup
Bakery	0.318	0.319	0.000	0.782	0.888	0.889	-0.001	2.181
Coffee	1.137	1.131	0.006	4.260	0.606	0.581	0.026	2.188
Cork	0.881	0.875	0.006	6.296	0.891	0.885	0.006	6.372
Glass	0.641	0.641	0.001	2.298	1.847	1.835	0.011	6.584
Kitchen Furniture	1.290	1.281	0.009	4.358	1.145	1.136	0.008	3.866
Manufacture of clothes of knitwear	0.158	0.156	0.001	0.413	0.988	0.986	0.002	2.605
Manufacture of concrete for building	1.110	1.114	-0.004	5.013	0.908	0.911	-0.003	4.099
Manufacture of Food for livestock	0.773	0.793	-0.020	12.114	0.683	0.674	0.009	10.296
Manufacture of knitwear	0.199	0.198	0.001	2.007	0.509	0.507	0.002	5.143
Manufacture of other outwear	0.467	0.464	0.003	1.205	0.806	0.802	0.004	2.085
Manufacture of paper	0.607	0.605	0.002	3.384	0.986	0.984	0.002	5.501
Manufacture of Plastics	0.460	0.452	0.009	2.636	1.232	1.218	0.013	7.108
Metal Doors, Windows	0.828	0.821	0.007	3.249	1.020	1.015	0.005	4.017
Milk and dairy Products	0.722	0.714	0.009	5.064	1.122	1.115	0.007	7.910
Moulds	0.727	0.729	-0.002	1.949	0.679	0.681	-0.002	1.821
Olive Oil	0.038	0.006	0.033	0.045	0.740	0.728	0.012	5.846
Pastries	0.461	0.458	0.003	1.177	1.085	1.084	0.002	2.787
Shoes	0.873	0.869	0.004	3.813	1.111	1.109	0.002	4.869
Stone Cutting	0.604	0.595	0.008	2.099	1.455	1.453	0.002	5.127
Wine	0.462	0.465	-0.003	2.286	1.529	1.537	-0.008	7.556
Wood Furniture	0.774	0.766	0.008	2.250	1.696	1.693	0.003	4.978

Source: Author's computation

Note: The set of instruments is level of capital stock with linear terms (for linear approximation), quadratic and cubic terms (for cubic approximation) of all variables lagged one period

TABLE XXII GMM Estimations: Median Mark-up obtained by Labour and Intermediate Inputs share

TFP transition Industry	RtS	δ	β	α	Median Markup	RtS	δ	β	α	Median Markup
Bakery	0.992	0.798	0.194	-0.001	1.035	1.023	0.701	0.323	0.000	1.067
Coffee	0.845	1.258	-0.413	0.001	0.957	0.888	1.346	-0.457	-0.001	1.008
Cork	1.050	0.749	0.301	-0.000	1.124	1.086	0.795	0.292	-0.002	1.164
Glass	0.744	0.824	-0.082	0.002	0.837	1.624	0.622	0.994	0.008	1.821
Kitchen Furniture	1.329	1.111	0.214	0.004	1.362	1.288	1.042	0.241	0.004	1.319
Manufacture of clothes of knitwear	1.195	0.956	0.240	-0.001	1.382	1.159	0.454	0.703	0.002	1.337
Manufacture of concrete for building	1.041	0.913	0.132	-0.004	1.121	0.866	1.119	-0.251	-0.002	0.932
Manufacture of Food for livestock	0.954	1.093	-0.140	0.002	0.974	0.976	1.047	-0.072	0.001	0.997
Manufacture of knitwear	0.919	0.992	-0.074	0.001	0.049	1.044	0.940	0.103	0.001	1.191
Manufacture of other Outwear	0.586	0.597	-0.011	0.001	0.677	1.799	1.389	0.410	0.000	2.081
Manufacture of paper	1.432	0.449	0.983	0.000	1.563	1.314	1.062	0.253	0.002	1.435
Manufacture of Plastics	0.495	1.226	-0.735	0.004	0.517	0.540	1.427	-0.893	0.006	0.564
Metal Doors and Windows	0.928	0.707	0.217	0.004	1.012	0.962	0.600	0.360	0.002	1.051
Milk and dairy Products	0.977	0.989	-0.014	0.002	1.057	0.962	1.017	-0.057	0.003	1.040
Moulds	0.815	0.253	0.566	-0.004	1.083	0.551	-0.174	0.727	-0.002	0.730
Olive Oil	1.054	0.987	0.076	-0.009	1.175	0.988	0.776	0.209	0.003	1.088
Pastries	1.016	0.996	0.018	0.002	1.024	1.029	1.050	-0.022	0.001	1.038
Shoes	0.926	1.073	-.0145	-0.001	1.073	0.916	0.923	-0.006	-0.001	1.061
Stone Cutting	0.973	1.061	-0.089	0.000	1.082	1.023	1.019	0.004	0.000	1.137
Wine	1.091	0.963	0.142	-0.015	1.237	1.682	0.892	0.809	-0.019	1.903
Wood Furniture	0.912	0.939	-0.029	0.002	1.001	1.245	0.555	0.688	0.002	1.367

Source: Author's computation

Note: The set of instruments is level of capital stock with linear terms (for linear approximation), quadratic and cubic terms (for cubic approximation) of all variables lagged one period

B.4 Indicators of median mark-up level

TABLE XXIII Correlation between log of output and mark-up level per industry

Industry	Coef.
Bakery	0.01
Coffee	-0.03
Cork	0.09
Glass	0.04
Kitchen Furniture	-0.05
Manufacture of clothes of knitwear	-0.04
Manufacture of concrete for building	0.08
Manufacture of Food for livestock	0.07
Manufacture of knitwear	0.02
Manufacture of other Outwear	-0.23
Manufacture of paper	-0.12
Manufacture of Plastics	-0.20
Metal Doors, Windows	0.05
Milk and dairy Products	-0.35
Moulds	-0.02
Olive Oil	-0.18
Pastries	0.03
Shoes	-0.36
Stone Cutting	-0.07
Wine	-0.06
Wood Furniture	-0.13

Source: Author's Computation

Coef stands for the coefficient of correlation between the log of output and median mark-up

TABLE XXIV Intensity and correlation between the log of physical stock of capital and median mark-up level

Industry	Intensity of Capital	Coef
Bakery	17.06%	0,02
Coffee	53.57%	-0,01
Cork	54.67%	0,17
Glass	32.77%	-0,25
Kitchen Furniture	34.58%	-0,17
Manufacture of clothes of knitwear	89.40%	0,22
Manufacture of concrete for building	42.35%	-0,07
Manufacture of Food for livestock	70.54%	-0,18
Manufacture of knitwear	49.65%	0,13
Manufacture of other Outwear	14.72%	0,07
Manufacture of paper	61.26%	-0,07
Manufacture of Plastics	76.83%	-0,28
Metal Doors, Windows	22.47%	0,01
Milk and dairy Products	60.11%	-0,31
Moulds	61.27%	-0,20
Olive Oil	84.48%	-0,11
Pastries	17.67%	0,09
Shoes	12.80%	-0,17
Stone Cutting	54.11%	-0,06
Wine	83.19%	-0,34
Wood Furniture	24.31%	-0,18

Source: Author's Computation
The physical stock of capital is measured in thousand of euros.
Coef stands for the coefficient of correlation between the log of physical stock of capital and the median mark-up

B.5 Analysis of Mark-up and TFP distribution

TABLE XXV Kolmogrov-Smirnov Normality Test for Mark-up

Industry	Mean	Std Dev	*p-stat*	*p-stat Corrected*
Olive oil	0.968	0.706	0.000	0.000
Bakery	1.414	0.423	0.029	0.026
Coffee	1.780	0.518	0.084	0.069
Cork	0.950	0.289	0.000	0.000
Glass	1.502	0.379	0.000	0.000
Kitchen Furniture	1.289	0.385	0.002	0.002
Manufacture of Clothes of Knitwear	0.482	0.179	0.000	0.000
Manufacture of Concrete for Building	1.119	0.362	0.003	0.002
Manufacture of Food for Livestock	1.049	0.247	0.000	0.000
Manufacture of Knitwear	1.272	0.295	0.000	0.000
Manufacture of other Outwear	1.467	0.887	0.000	0.000
Manufacture of Paper	1.396	1.279	0.000	0.000
Manufacture of Plastics	1.054	0.316	0.010	0.008
Metal Doors and Windows	1.422	0.594	0.000	0.000
Milk and Dairy Products	1.190	0.236	0.005	0.004
Moulds	1.164	0.371	0.000	0.000
Pastries	1.529	0.487	0.000	0.000
Shoes	1.659	0.440	0.000	0.000
Stone Cutting	1.205	0.374	0.000	0.000
Wine	1.168	0.646	0.000	0.000
Wood Furniture	1.542	0.452	0.000	0.000

Source: Author's computation

TABLE XXVI Unit root test for TFP and Mark-up

Industry	TFP *p-Stat*	Markup *p-Stat*
Bakery	0.837	0.896
Coffee	0.483	0.873
Cork	0.590	0.734
Glass	0.977	0.839
Kitchen Furniture	0.872	0.625
Manufacture of Clothes of Knitwear	0.917	0.953
Manufacture of Concrete for building	0.591	0.842
Manufacture of Food for Livestock	0.611	0.927
Manufacture of Knitwear	0.912	0.795
Manufacture of other Outwear	0.830	0.911
Manufacture of Paper	0.923	0.970
Manufacture of Plastic	0.680	0.893
Metal Doors and Windows	0.750	0.695
Milk and dairy Products	0.493	0.822
Moulds	0.924	0.780
Olive Oil	0.436	0.780
Pastries	0.686	0.915
Shoes	0.656	0.684
Stone Cutting	0.795	0.746
Wine	0.905	0.921
Wood Furniture	0.729	0.729

Source: Author's Computation